Clemson University
3 1604 019 888 017

Digitized by the Internet Archive
in 2013

http://archive.org/details/watersupplyirrig6571unit

I 19.13 :65

DEPARTMENT OF THE INTERIOR

CLEMSON COLLEGE LIBRARY
GOVERMENT PUBLICATIONS

WATER-SUPPLY

AND

IRRIGATION PAPERS

OF THE

UNITED STATES GEOLOGICAL SURVEY

No. 65

OPERATIONS AT RIVER STATIONS, 1901, PART I
(EAST OF MISSISSIPPI RIVER)

WASHINGTON
GOVERNMENT PRINTING OFFICE
1902

IRRIGATION REPORTS.

The following list contains titles and brief descriptions of the principal reports relating to water supply and irrigation prepared by the United States Geological Survey since 1890:

1890.

First Annual Report of the United States Irrigation Survey, 1890; octavo, 123 pp.

Printed as Part II, Irrigation, of the Tenth Annual Report of the United States Geological Survey, 1888–89. Contains a statement of the origin of the Irrigation Survey, a preliminary report on the organization and prosecution of the survey of the arid lands for purposes of irrigation, and report of work done during 1890.

1891.

Second Annual Report of the United States Irrigation Survey, 1891; octavo, 395 pp.

Published as Part II, Irrigation, of the Eleventh Annual Report of the United States Geological Survey, 1889–90. Contains a description of the hydrography of the arid region and of the engineering operations carried on by the Irrigation Survey during 1890; also the statement of the Director of the Survey to the House Committee on Irrigation, and other papers, including a bibliography of irrigation literature. Illustrated by 29 plates and 4 figures.

Third Annual Report of the United States Irrigation Survey, 1891; octavo, 576 pp.

Printed as Part II of the Twelfth Annual Report of the United States Geological Survey, 1890–91. Contains "Report upon the location and survey of reservoir sites during the fiscal year ended June 30, 1891," by A. H. Thompson; "Hydrography of the arid regions," by F. H. Newell; "Irrigation in India," by Herbert M. Wilson. Illustrated by 93 plates and 190 figures.

Bulletins of the Eleventh Census of the United States upon irrigation, prepared by F. H. Newell; quarto.

No. 35, Irrigation in Arizona; No. 60, Irrigation in New Mexico; No. 85, Irrigation in Utah; No. 107, Irrigation in Wyoming; No. 153, Irrigation in Montana; No. 157, Irrigation in Idaho; No. 163, Irrigation in Nevada; No. 178, Irrigation in Oregon; No. 193, Artesian wells for irrigation; No. 198, Irrigation in Washington.

1892.

Irrigation of western United States, by F. H. Newell; extra census bulletin No. 23, September 9, 1892; quarto, 22 pp.

Contains tabulations showing the total number, average size, etc., of irrigated holdings, the total area and average size of irrigated farms in the subhumid regions, the percentage of number of farms irrigated, character of crops, value of irrigated lands, the average cost of irrigation, the investment and profits, together with a résumé of the water supply and a description of irrigation by artesian wells. Illustrated by colored maps showing the location and relative extent of the irrigated areas.

1893.

Thirteenth Annual Report of the United States Geological Survey; 1891–92, Part III, Irrigation, 1893; octavo, 486 pp.

Consists of three papers: "Water supply for irrigation," by F. H. Newell; "American irrigation engineering" and "Engineering results of the Irrigation Survey," by Herbert M. Wilson; and "Construction of topographic maps and selection and survey of reservoir sites," by A. H. Thompson. Illustrated by 77 plates and 119 figures.

A geological reconnoissance in central Washington, by Israel Cook Russell, 1893; octavo, 108 pp., 15 plates. Bulletin No. 108 of the United States Geological Survey.

Contains a description of the examination of the geologic structure in and adjacent to the drainage basin of Yakima River and the great plains of the Columbia to the east of this area, with special reference to the occurrence of artesian waters.

1894.

Report on agriculture by irrigation in the western part of the United States at the Eleventh Census, 1890, by F. H. Newell, 1894; quarto, 283 pp.

Consists of a general description of the condition of irrigation in the United States, the area irrigated, cost of works, their value and profits; also describes the water supply, the value of water, of artesian wells, reservoirs, and other details; then takes up each State and Territory in order, giving a general description of the condition of agriculture by irrigation, and discusses the physical conditions and local peculiarities in each county.

Fourteenth Annual Report of the United States Geological Survey, 1892–93, in two parts; Part II, Accompanying papers, 1894; octavo, 597 pp.

Contains papers on "Potable waters of the eastern United States," by W J McGee; "Natural mineral waters of the United States," by A. C. Peale; and "Results of stream measurements," by F. H. Newell. Illustrated by maps and diagrams.

(Continued on third page of cover.)

DEPARTMENT OF THE INTERIOR

WATER-SUPPLY

AND

IRRIGATION PAPERS

OF THE

UNITED STATES GEOLOGICAL SURVEY

No. 65

WASHINGTON
GOVERNMENT PRINTING OFFICE
1902

UNITED STATES GEOLOGICAL SURVEY

CHARLES D. WALCOTT, DIRECTOR

OPERATIONS AT RIVER STATIONS, 1901

A REPORT OF THE

DIVISION OF HYDROGRAPHY

OF THE

UNITED STATES GEOLOGICAL SURVEY

PART I—(EAST OF MISSISSIPPI RIVER)

WASHINGTON
GOVERNMENT PRINTING OFFICE
1902

CONTENTS.

	Page.
Maine rivers	13
Penobscot River	14
Kennebec River	16
Kennebec River at The Forks, Me	16
Kennebec River at North Anson, Me	16
Roach River at Roach River, Me	17
Dead River at The Forks, Me	18
Carrabasset River at North Anson, Me	19
Cobbosseecontee River at reservoir dam near Augusta, Me	19
Androscoggin River at Rumford Falls, Me	20
Presumpscot River at outlet of Sebago Lake, Maine	21
Other New England rivers	22
Merrimac River at Lawrence, Mass	22
South Branch of Nashua River at Clinton, Mass	22
Sudbury River and Lake Cochituate, Mass	26
Mystic Lake, Massachusetts	27
Blackstone River at Berkeley, R. I	27
Connecticut River at Orford, N. H	29
Connecticut River at Holyoke, Mass	30
Connecticut River near Hartford, Conn	30
St. Lawrence River drainage basin	31
Oswegatchie River	33
Raquette River	36
Lake Champlain outlet at Fort Montgomery, Clinton County, N. Y	38
Upper Hudson River drainage	42
Indian River at Indian Lake dam, Hamilton County, N. Y	42
Schroon River at Warrensburg, Warren County, N. Y	45
Hudson River at Fort Edward, Washington County, N. Y	48
Hudson River at Mechanicville, Saratoga County, N. Y	50
Lower Hudson River and Long Island Sound drainage	53
Kinderhook Creek at East Nassau and Wilson's dam, Rensselaer County, N. Y	53
Normanskill Creek at French's mill, Albany County, N. Y	58
Gagings of streams proposed as sources of public water supply for New York City	59
Catskill Creek at South Cairo, Greene County, N. Y	61
Esopus Creek at Kingston, Ulster County, N. Y	63
Rondout Creek at Rosendale, Ulster County, N. Y	66
Diversion from Rondout Creek to feed Delaware and Hudson Canal	68
Rondout Creek at Honk Falls, Ulster County, N. Y	69
Wallkill River at New Paltz, Ulster County, N. Y	71
Fishkill Creek at Glenham, Dutchess County, N. Y	74
Croton River at old Croton dam, Westchester County, N. Y	76
Tenmile River below Dover Plains, Dutchess County, N. Y	85
Housatonic River at Gaylordsville, Conn	87
Miscellaneous gagings of Housatonic River	90

Methods employed in gaging New York streams 91
Formulas 95
Description of tables of daily discharge 97
Lake Ontario drainage 98
Moose River below McKeever, Herkimer County, N. Y 98
Beaver River at Tisse's bridge, Lewis County, N. Y 100
Black River at Huntingtonville, Jefferson County, N. Y 102
Salmon River above Pulaski, Oswego County, N. Y 105
West Branch of Fish Creek at McConnellsville, Oneida County, N. Y 108
Oneida Creek at Kenwood, Madison County, N. Y 110
Chittenango Creek at Bridgeport, Madison County, N. Y 112
Chittenango Creek at Chittenango, Madison County, N. Y 114
Skaneateles Lake Outlet 116
Seneca River at Baldwinsville, Onondaga County, N. Y 128
Oneida River at Brewerton, Onondaga County, N. Y 131
Low-water gagings of Oswego River at Fulton, Oswego County, N. Y 133
Oswego River above Minetto, Oswego County, N. Y 134
Oswego River at high dam, Oswego County, N. Y 137
Genesee River at Rochester, Monroe County, N. Y 139
Mohawk River drainage 142
Mohawk River at Ridge Mills, Oneida County, N. Y 144
Oriskany Creek at Oriskany, Oneida County, N. Y 145
Oriskany Creek at Wood road bridge, Oriskany, Oneida County, N. Y 147
Sauquoit Creek at New York Mills, Oneida County, N. Y 149
Sauquoit Creek at Yorkville, Oneida County, N. Y 150
Mohawk River at Utica, Oneida County, N. Y 151
West Canada Creek at Twin Rock bridge and Trenton Falls, Oneida County, N. Y 153
West Canada Creek at Middleville, Herkimer County, N. Y 155
East Canada Creek at Dolgeville, Herkimer County, N. Y 158
Mohawk River at Little Falls, Herkimer County, N. Y 162
Mohawk River at Rocky Rift dam, Herkimer County, N. Y 165
Cayadutta Creek near Johnstown, Fulton County, N. Y 166
Schoharie Creek at Fort Hunter dam and aqueduct, Montgomery County, N. Y 167
Schoharie Creek at Mill Point, Montgomery County, N. Y 169
Schoharie Creek at Schoharie Falls, Montgomery County, N. Y 170
Mohawk River at Schenectady, Schenectady County, N. Y 172
Mohawk River at Rexford Flats, Saratoga County, N. Y 176
Mohawk River near Dunsbach Ferry, Saratoga County, N. Y 180
Mohawk River slope gagings 184
Middle Atlantic Coast drainage 210
Passaic River, New Jersey 210
Passaic River at Two Bridges, N. J 210
Pompton River at Two Bridges, N. J 211
Stream measurements in southern New Jersey 212
Tuckahoe River, New Jersey 212
Manantico Creek, New Jersey 213
Lehigh River near Bethlehem, Pa 213
Delaware River at Lambertville, N. J 214
Tohickon Creek at Point Pleasant, Pa 215
Neshaminy Creek, Pennsylvania, below the forks 216
Perkiomen Creek at Frederick, Pa 217

Page.
Middle Atlantic Coast drainage—Continued.
Wissahickon Creek near Philadelphia, Pa 218
Schuylkill River above Philadelphia, Pa 219
North Branch of Susquehanna River at Wilkesbarre, Pa 220
North Branch of Susquehanna River at Danville, Pa 220
West Branch of Susquehanna River at Williamsport, Pa 221
West Branch of Susquehanna River at Allenwood, Pa 225
Juniata River at Newport, Pa 226
Susquehanna River at Harrisburg, Pa 227
Patapsco River at Woodstock, Md 228
North Branch of Potomac River at Piedmont, W. Va 229
South Branch of Potomac River near Springfield, W. Va 229
Antietam Creek near Sharpsburg, Md 230
North Branch of Shenandoah River near Riverton, Va 231
South Branch of Shenandoah River at Front Royal, Va 232
Shenandoah River at Millville, W. Va 233
Potomac River at Point of Rocks, Md 233
Monocacy River near Frederick, Md 234
North (of James) River at Glasgow, Va 235
James River at Buchanan, Va 236
James River at Holcomb Rock, Va 237
James River at Cartersville, Va 238
Appomattox River at Mattoax, Va 238
Southern Atlantic Coast drainage 239
Staunton River at Randolph, Va 239
Dan River at South Boston, Va 240
Roanoke River at Roanoke, Va 241
Roanoke River at Neal, N. C 242
Deep River at Cumnock, N. C 243
Cape Fear River at Fayetteville, N. C 244
Yadkin River at Siloam, N. C 245
Yadkin River at Salisbury, N. C 246
Catawba River near Morganton, N. C 247
John River near Morganton, N. C 247
Catawba River at Catawba, N. C 247
Catawba River near Rockhill, S. C 248
Broad River (of the Carolinas) at Dellinger, S. C 249
Broad River (of the Carolinas) near Alston, S. C 250
Saluda River at Waterloo, S. C 250
Tallulah River at Tallulah Falls, Ga 251
Tugaloo River near Madison, S. C 252
Savannah River near Calhoun Falls, S. C 253
Savannah River at Augusta, Ga 254
Broad River (of Georgia) near Carlton, Ga 255
Middle Oconee River near Athens, Ga 256
Oconee River at Barnett Shoals, Ga 257
Apalachee River near Buckhead, Ga 258
Oconee River near Dublin, Ga 259
Alcovy River near Covington, Ga 260
Yellow River at Almon, Ga 261
Ocmulgee River near Flovilla, Ga 262
Miscellaneous measurement of streams in Altamaha River drainage 263
Towaliga River near Juliette, Ga 263
Ocmulgee River at Macon, Ga 264

Eastern Gulf drainage 26
Flint River at Woodbury, Ga 265
Flint River at Albany, Ga 266
Chattahoochee River near Gainesville, Ga 267
Chattahoochee River near Buford, Ga 268
Chattahoochee River at Oakdale, Ga 269
Chattahoochee River at West Point, Ga 270
Hillabee Creek near Alexander City, Ala 271
Tallapoosa River near Sturdevant, Ala 272
Big Sandy Creek near Dadeville, Ala 273
Tallapoosa River near Susanna, Ala 273
Tallapoosa River near Milstead, Ala 274
Etowah River at Canton, Ga 275
Coosawattee River at Carters, Ga 276
Oostanaula River at Resaca, Ga 277
Coosa River at Rome, Ga 278
Coosa River near Riverside, Ala 279
Coosa River at Locks Nos. 4 and 5, Alabama 280
Talladega Creek at Nottingham, Ala 281
Alabama River at Montgomery, Ala 281
Alabama River at Selma, Ala 282
Cahaba River at Centerville, Ala 283
Mulberry Fork of Black Warrior River near Cordova, Ala 283
Black Warrior River at Tuscaloosa, Ala 284
Tombigbee River at Columbus, Miss 285
Tombigbee River at Epes, Ala 286
Pearl River at Jackson, Miss 286
Eastern Mississippi River drainage 287
Yazoo River at Yazoo City, Miss 287
Youghiogheny River at Friendsville, Md 289
Indian Creek 289
Cheat River near Uneva, W. Va 290
Greenbrier River at Alderson, W. Va 290
North Fork of New River at Weaversford, N. C 291
South Fork of New River at New River, N. C 292
New River near Oldtown, Va 293
New River at Radford, Va 293
New River at Fayette, W. Va 294
Olentangy River at Columbus, Ohio 295
Scioto River at Columbus, Ohio 295
Cumberland River at Nashville, Tenn 296
South Fork of Holston River at Bluff City, Tenn 297
Watauga River at Butler Tenn 298
Roan Creek at Butler, Tenn 299
Elk Creek at Lineback, Tenn 299
Nolichucky River near Chucky Valley, Tenn 300
French Broad River near Asheville, N. C 301
French Broad River at Oldtown, Tenn 302
Pigeon River at Newport, Tenn 302
Tennessee River at Knoxville, Tenn 303
Tuckasegee River at Bryson, N. C 304
Little Tennessee River at Judson, N. C 305
Hiwassee River at Murphy, N. C 306

Page.
Eastern Mississippi River drainage—Continued.
Nottely River at Ranger, N. C. 307
Hiwassee River at Reliance, Tenn 308
Hiwassee River at Charleston, Tenn 309
Toccoa River near Blueridge, Ga 310
Tennessee River at Chattanooga, Tenn 311
Miscellaneous discharge measurements of Appalachian streams 312
Mississippi River at St. Paul, Minn 312
Great Lakes drainage 313
Maumee River near Waterville, Ohio 313
Sandusky River at Fremont, Ohio 314
Grand River at North Lansing, Mich 315
Grand River at Grand Rapids, Mich 315
Rating tables 318
Index 325

LETTER OF TRANSMITTAL.

DEPARTMENT OF THE INTERIOR,
UNITED STATES GEOLOGICAL SURVEY,
DIVISION OF HYDROGRAPHY,
Washington, D. C., May 17, 1902.

SIR: I have the honor to transmit herewith a manuscript giving the results of operations at various river stations in 1901, and request that it be published in the series of Water-Supply and Irrigation Papers. The material has been divided into two parts, the first part relating to the eastern portion of the country and the second part to the western.

The general conclusions drawn from the operations at the river stations, together with diagrams, maps, and illustrations, are being prepared for publication in the new Professional Papers series, being designed to be in form and substance similar to preceding volumes known as Part IV of the Eighteenth to the Twenty-second Annual Reports.

Very respectfully,

F. H. NEWELL,
Hydrographer in Charge.

Hon. CHARLES D. WALCOTT,
Director United States Geological Survey.

OPERATIONS AT RIVER STATIONS, 1901.

PART I.—(EAST OF MISSISSIPPI RIVER.)

MAINE RIVERS.

The rivers of the State of Maine furnish some of the best water-power sites in the United States. The large rivers have their sources in general at high elevations among the mountains and hills of the central and northern part of the State. Their fall is rapid, with frequent vertical drops over granite ledges. Building stone is abundant in nearly all the drainage basins. The rocky beds furnish excellent foundations for dams and mills, and the excellent harbors along the coast, together with the railroad lines following the lower courses of the streams, give for a large part of the State excellent transportation facilities. The extensive lake areas, aggregating 2,300 square miles, furnish natural reservoirs for the storage of storm waters that could not be equaled throughout the United States. In addition to the lakes, the extensive forests covering the greater part of the State and the gravelly and porous soil tend to make the flow of the Maine rivers remarkably uniform.

During the summer of 1901 the United States Geological Survey commenced the hydrographic study of the State of Maine. Prior to that time records of flow from a few of the main rivers had been furnished by engineers and manufacturing companies and published in the reports of the Survey. It is hoped that these records may be continued and that the investigations may be extended, so that definite information may be obtained of the flow, fall, and the possibilities of increased storage on all of the larger streams of the State.

In the following pages the records of flow for the year 1901 are published for all stations for which such figures are available. In addition to these, gage heights are given at a number of the new stations established by the Survey, with the results of current-meter measurements made from time to time. As soon as these stations have been continued for a sufficient period to permit of the construction of a rating curve for the stations, the records of flow for each day of the year will be published.

During 1901 rain gages were established by the Survey at The Forks, Roach River, Northeast Carry, Jackman, and Wytopitlock,

and by the Kennebec Water Power Company at Kineo. Gaging stations were selected by H. A. Pressey and N. C. Grover, professor of civil engineering, University of Maine, and established by the Survey in the same year on the Kennebec River at The Forks and North Anson, on Roach River at Roach River, on Dead River at The Forks, on Carrabasset River at North Anson, and on Penobscot River at Montague.

Descriptions of the drainage areas of the Maine rivers will be found in Water-Supply and Irrigation Paper No. 69, and records of flow for past years will be found in the same paper.

PENOBSCOT RIVER.

The Penobscot is the largest of the Maine rivers flowing into the Atlantic, and owing to its large fall and its numerous lakes is important as a water-power stream. The basin is described in Water-Supply and Irrigation Paper No. 69. Few measurements of flow have been made on the river, but the results of two measurements made at Orono, in 1884 and 1886, are given in Water-Supply and Irrigation Paper No. 69.

A record of the flow at Sunk Haze Rips, near Costigan, Me., was kept from September 15, 1899, to September 22, 1900. The rating curve was constructed from tube-float measurements made by George F. Hardy and reported to the supreme court of Maine on October 23, 1901. The drainage basin at Sunk Haze Rips has an area of 7,450 square miles. The results of the measurements at this point are given in the following table:

Daily discharge, in second-feet, of Penobscot River at Sunk Haze Rips, Costigan, Me., for 1899.

Day.	Sept.	Oct.	Nov.	Dec.	Day.	Sept.	Oct.	Nov.	Dec.
1		3,450	3,300	4,800	18	2,350	2,330	4,400	10,150
2		4,250	5,600	5,100	19	2,900	2,330	5,100	10,150
3		5,100	10,850	5,950	20	2,380	2,390	5,250	10,500
4		3,900	12,200	8,000	21	2,450	2,430	5,950	11,000
5		3,550	11,000	8,750	22	2,750	2,350	6,240	11,250
6		3,360	10,850	8,650	23	2,670	2,100	6,700	11,200
7		3,190	10,500	8,650	24	2,850	2,670	6,800	10,300
8		3,300	14,000	7,700	25	2,450	2,420	6,450	9,850
9		3,200	9,090	8,500	26	[a]3,410	2,320	5,600	9,750
10		3,100	8,300	7,900	27	[a]3,300	2,100	5,100	9,200
11		3,100	7,620	7,440	28	3,140	2,330	5,250	8,850
12		2,950	7,300	7,230	29	3,020	2,160	5,600	8,570
13		2,750	6,020	9,400	30	3,190	[a]2,000	5,800	8,400
14		2,630	6,240	11,500	31	.....	2,550	.....	9,430
15	2,830	2,630	6,100	11,500					
16	2,640	2,330	6,100	10,000	Mean	2,808	2,764	7,170	9,014
17	2,600	2,410	5,800	9,750					

[a] Shut down at Montague.

Daily discharge, in second-feet, of Penobscot River at Sunk Haze Rips, Costigan, Me., for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	9,500	36,000	47,600	40,300	59,400	34,300	11,900	14,100	5,950
2	10,000	35,800	47,500	39,600	54,800	30,300	12,200	13,550	5,950
3	10,500	33,700	45,600	41,300	54,100	36,300	11,900	12,900	5,950
4	11,700	32,200	44,400	44,500	61,200	41,600	11,300	12,700	5,950
5	11,900	31,700	42,300	46,600	72,500	38,200	11,700	12,400	6,100
6	11,200	31,800	41,400	43,800	74,700	34,700	12,500	12,400	6,950
7	11,000	31,500	39,400	42,600	69,900	32,300	12,800	12,050	6,800
8	10,000	31,000	37,700	45,300	66,900	30,300	12,800	12,050	6,250
9	10,150	30,000	36,500	48,800	63,600	27,400	13,200	12,050	5,800
10	10,150	29,200	35,100	44,500	63,000	24,200	14,100	12,050	5,400
11	10,150	27,200	33,600	48,800	61,700	24,200	14,100	12,050	3,140
12	12,600	26,200	32,650	36,600	58,000	23,900	14,100	13,400	3,270
13	13,600	27,150	31,100	38,000	53,400	24,300	14,400	13,200	3,100
14	13,150	29,800	30,500	42,600	49,400	22,000	13,900	12,700	3,270
15	12,750	43,000	29,800	44,500	50,100	18,400	14,600	12,400	3,350
16	12,200	51,000	29,200	46,100	54,100	19,000	14,000	13,400	3,250
17	11,950	52,400	34,800	48,100	50,700	17,500	11,900	12,400	3,050
18	12,400	49,900	44,100	49,400	50,800	14,600	13,200	12,050	3,020
19	12,200	47,300	33,200	54,800	48,800	13,600	16,900	11,900	2,800
20	11,800	45,000	32,500	62,400	54,100	12,600	21,400	11,700	2,620
21	11,850	43,000	62,700	62,000	62,400	10,500	18,700	11,200	2,880
22	12,600	39,700	62,500	75,100	55,700	9,700	14,400	10,450	
23	13,600	38,300	61,300	74,700	61,700	12,200	12,900	9,000	
24	14,850	35,700	59,500	71,400	60,000	10,150	11,300	7,650	
25	15,650	34,800	58,000	69,600	57,800	9,400	11,300	6,350	
26	16,300	38,300	55,500	67,500	55,000	8,300	12,200	4,850	
27	19,000	44,400	54,800	65,300	50,800	8,150	15,100	6,600	
28	27,500	47,300	57,500	61,700	49,800	7,800	15,100	6,450	
29	32,000	.....	48,100	59,500	47,100	9,000	14,800	6,150	
30	33,500	.....	44,500	56,800	44,200	10,150	14,600	5,950	
31	35,400	.....	41,300	.....	39,900	.....	13,550	6,200	
Mean	14,876	37,262	43,828	52,407	56,632	20,435	13,769	10,722	4,507

A gaging station was established by the United States Geological Survey at Montague on November 5, 1901. The drainage area at Montague is 6,890 square miles. The measurements are made from the bridge across the Penobscot. A wire gage was established, reading to feet and tenths and referred to a bench mark, the top of the northwest corner of second course below bridge seat, easterly abutment, the elevation being 25.78 feet. The initial point of sounding is at the extreme end of the inclined end post on upstream side of bridge. The channel is straight for 1,000 feet above and 3,000 feet below the station, and the current is swift. The banks are high and rocky, and the bed rocky, with some gravel. The gage is read twice daily—7 a. m. and 5 p. m.—by A. H. Hanson, a merchant in Montague. The measurements made on November 5, 1901, when the gage height was 2 feet, gave a discharge of 3,073 cubic feet per second.

Daily gage height, in feet, of the Penobscot River at Montague, Me., for 1901.

Day.	Nov.	Dec.	Day.	Nov.	Dec.	Day.	Nov.	Dec.	Day.	Nov.	Dec.
1	.....	2.0	9	2.3	2.0	17	2.1	14.5	25	2.2	5.95
2	.....	2.0	10	2.4	2.1	18	2.2	11.8	26	2.2	6.2
3	.....	2.0	11	2.5	2.5	19	2.2	8.75	27	2.1	5.9
4	.....	2.0	12	2.5	3.3	20	2.2	7.8	28	2.0	5.45
5	2.0	2.0	13	2.5	3.8	21	2.0	7.1	29	2.0	5.1
6	2.0	2.0	14	2.3	4.5	22	2.0	6.45	30	2.0	5.3
7	2.0	2.0	15	2.2	6.2	23	2.35	6.0	31	.....	5.4
8	2.15	2.0	16	2.2	14.0	24	2.2	5.85			

KENNEBEC RIVER.

As stated on page 14, a number of stations were established in the fall of 1901 on the Kennebec River and its tributaries. Since 1892 records have been kept at Waterville by the Hollingsworth & Whitney Pulp and Paper Company, and have been published by the Survey. A summary of these results will be found in Water-Supply Paper No. 69. Records for the year 1901 are not now available, but it is hoped that these can be published in a later report.

KENNEBEC RIVER AT THE FORKS, ME.

This station was established by N. C. Grover, September 28, 1901, at the bridge across the Kennebec River at The Forks. The gage is a vertical rod, graduated to feet and tenths, and referred to a bench mark which is the top of a bolt on east abutment, north end of bridge; the elevation of the bench mark is 12.85 feet. The initial point of sounding is on the left bank, marked by a rod across the bridge, just above the abutment and below the bridge floor. The channel is straight above the station for about 200 feet and below for a distance of 500 feet. The current is swift, the banks high and rocky, with a rocky and permanent stream bed. The gage is read twice daily, 7 a. m. and 5 p. m., by William W. Young. The drainage area of the Kennebec River at this point is 1,640 square miles. The following measurements of flow of the Kennebec were made during 1901 by N. C. Grover:

September 28, 1901: Gage height, 2.7 feet; discharge, 1,841 cubic feet per second.

October 20, 1901: Gage height, 1 foot; discharge, 469 cubic feet per second.

Daily gage height, in feet, of Kennebec River at The Forks, Me., for 1901.

Day.	Sept.	Oct.	Nov.	Dec.	Day.	Sept.	Oct.	Nov.	Dec.	Day.	Sept.	Oct.	Nov.	Dec.
1		2.4	2.6		12		2.55	1.7	3.0	23		1.25	2.05	
2		2.4	2.6		13		2.55	1.8	3.4	24		2.05	2.0	
3		2.4	2.6		14		2.65	1.7	4.0	25		2.15	2.0	
4		2.4	2.6		15		2.95	2.0	9.0	26		2.05	2.0	
5		2.5	2.5		16		2.0	2.0	8.0	27		2.05	2.0	
6			2.25		17		1.45	2.0	8.0	28		2.0	2.0	
7		2.4	2.15		18		1.15	2.0	7.0	29	2.6	2.0	2.0	
8		2.4	2.05		19		.9	2.0	6.0	30	2.5	2.5	2.0	
9		2.5	2.05	2.5	20		.9	2.0		31		2.5		
10		2.5	1.9	3.0	21		1.0	2.0						
11		2.4	1.8	3.0	22		.9	2.0						

KENNEBEC RIVER AT NORTH ANSON, ME.

This station was established on October 18, 1901, by N. C. Grover. It is located 1½ miles east of North Anson, and is reached by private conveyance. Measurements are made from the bridge across the Kennebec. The gage is a vertical rod graduated to feet and tenths and fastened to the bridge pier. It is referred to two bench marks, one being the top of pier back of gage, elevation 22.5 feet,

and the other the top of the southeast corner of the twelfth stone from the top of west abutment, elevation 9.55 feet. The initial point of sounding is on the left bank at the outside of the end post of the bridge. The channel is straight above the station for 500 feet, and below for 1,000 feet. The current is swift, the right bank high and rocky, while the left bank is comparatively low and subject to overflow at the time of highest water. The bed of the stream is rocky, with sand over a portion of the section. The gage is read twice daily, at 8 a. m. and 4 p. m., by H. C. Stetson, the toll collector at the bridge. The drainage area is 2,925 square miles. The following measurements were made during 1901 by N. C. Grover:

October 14, 1901: gage height, 3.2 feet; discharge, 3,145 cubic feet per second.

October 18, 1901: gage height, 3 feet; discharge, 2,465 cubic feet per second.

Daily gage height, in feet, of Kennebec River at North Anson, Me., for 1901.

Day.	Oct.	Nov.	Dec.	Day.	Oct.	Nov.	Dec.	Day.	Oct.	Nov.	Dec.
1		3.0	4.9	12		2.5		23	2.2	2.55	
2		3.0	5.0	13		2.55		24	2.55	2.5	
3		2.85	5.15	14		2.85		25	2.85	2.7	
4		3.1		15		2.75		26	2.8	2.7	
5		3.0		16		2.75		27	2.7	2.8	
6		2.9		17		2.7		28	2.7	4.55	
7		2.7		18		2.7		29	2.7	5.15	
8		2.5		19		2.7		30	2.75	5.0	
9		2.55		20	2.45	2.7		31	2.9		
10		2.55		21	2.3	2.8					
11		2.35		22	2.25	2.85					

ROACH RIVER AT ROACH RIVER, ME.

This stream, entering Moosehead Lake from the east, rises in the highland region of Maine, its basin being well wooded and containing several ponds of considerable size. At the foot of Lower Roach Pond is a dam, owned by the log drivers, which controls the flow of the river. The drainage area of the river at this point is 70 square miles. The station at Roach River was established November 10, 1901, by N. C. Grover. It is reached by a stage from Lily Bay. The gage is a vertical rod spiked to the timber retaining embankment on the left bank of the stream. It is divided into feet and tenths and referred to a bench mark, a cross on the top timber to which the gage is spiked, the elevation of this mark being 9 feet. The gage is read twice daily, at 9 a. m. and 3 p. m., by C. H. Sawyer, hotel keeper. No measurements have been made during 1901.

Daily gage height, in feet, of Roach River at Roach River, Me., for 1901.

Day.	Nov.	Dec.	Day.	Nov.	Dec.	Day.	Nov.	Dec.	Day.	Nov.	Dec.
1		2.3	9		2.3	17	2.3	3.5	25	2.2	3.35
2		2.3	10	2.2	2.3	18	2.2	3.5	26	2.2	3.65
3		2.3	11	2.2	2.3	19	2.2	3.5	27	2.2	3.4
4		2.3	12	2.2	2.3	20	2.2	3.5	28	2.2	2.95
5		2.3	13	2.2	2.3	21	2.2	3.5	29	2.3	2.8
6		2.3	14	2.35	2.3	22	2.2	3.5	30	2.3	2.8
7		2.3	15	2.3	2.65	23	2.2	3.25	31		2.8
8		2.3	16	2.3	3.1	24	2.2	3.0			

DEAD RIVER AT THE FORKS, ME.

This tributary of the Kennebec has its headwaters in the mountains between Maine and Canada and flows in a general easterly direction, entering the Kennebec at The Forks. Its basin contains 840 square miles and is 40 miles in extreme length by 30 in width and completely wooded. Through a large portion of its length the river flows through swamps; in its lower course it has considerable fall. The only dams on the stream are owned by the log-driving companies, and the gates are kept open after the drive is out of the river. The station is 1½ miles west from The Forks and is reached by private conveyance. The measurements are made from a boat guided by a half-inch manila rope stretched across the river. The gage is a vertical rod graduated to feet and tenths and referred to two bench marks. One is on the right bank on the top of large bowlder at end of wharf on which gage is placed; its elevation is 4.48 feet. The other is on the left bank, 200 feet above the gage, on the top of bowlder; its elevation is 10.89 feet. The channel is straight for 500 feet above and below the gage, the current swift. The banks are rocky, though subject to overflow at the time of highest water. The bed is rocky and permanent. The gage is read twice daily, 6 a. m. and 6 p. m., by Jeremiah Durgin, jr., a farmer at The Forks.

A measurement of the flow at The Forks was made on September 29, 1901, when the gage reading was 0.4 feet and the discharge 253 cubic feet per second.

Daily gage height, in feet, of Dead River at The Forks, Me., for 1901.

Day.	Sept.	Oct.	Nov.	Dec.	Day.	Sept.	Oct.	Nov.	Dec.
1		0.35	0.5	0.8	17		1.6	0.5	
2		.4	.4	.8	18		1.3	.4	
3		.4	.5	.7	19		.95	.4	
4		.4	.5	.7	20		.85	.5	
5		.4	.45	.7	21		.8	.5	
6		.4	.4	.8	22		.65	.5	
7		.3	.4	.8	23		.7	.6	
8		.3	.4		24		.8	.6	
9		.3	.4		25		.8	.6	
10		.3	.4		26		.7	.6	
11		.3	.4		27		.7	.7	
12		.3	.4		28		.7	.7	
13		.4	.4		29	0.4	.6	.7	
14		.5	.5		30	.4	.55	.8	
15		.8	.5		31		.5		
16		1.5	.5						

CARRABASSET RIVER AT NORTH ANSON, ME.

This river enters the Kennebec from the west at North Anson. Its basin has steep slopes, partly in farm lands, with no natural reservoirs. Dams have been constructed and power used at New Portland, East New Portland, and North Anson. The drainage area is 330 square miles. On October 19, 1901, a gaging station was established on the Carrabasset, 4 miles west of North Anson, by N. C. Grover. The gaging is made from a boat held in position by a manila rope stretched across the stream. The gage is a vertical rod graduated to feet and tenths, and referred to a bench mark on a blazed spruce tree 40 feet from the gage. The elevation of bench mark is 10.78 feet. The gage is read every morning by N. Q. Hilton, a farmer in North Anson, Me. No measurements have been made at this station.

Daily gage height, in feet, of Carrabasset River, at North Anson, Me., for 1901.

Day.	Nov.	Dec.	Day.	Nov.	Dec.	Day.	Nov.	Dec.	Day.	Nov.	Dec.
1		0.6	9	0.3		17	0.2		25	0.2	
2		.6	10	.3		18	.2		26	.2	
3	0.4	.6	11	.3		19	.5		27	.2	
4	.4	.5	12	.2		20	.4		28	.2	
5	.4	.5	13	.2		21	.3		29	.2	
6	.3	.5	14	.2		22	.2		30	.1	
7	.3		15	.2		23	.2		31		
8	.3		16	.2		24	.2				

COBBOSSEECONTEE RIVER AT RESERVOIR DAM NEAR AUGUSTA, ME.

This river is described in Water-Supply Paper No. 69, and records of discharge measurements from 1890 to 1901, inclusive, will be found in the same paper. The measurements are made at the reservoir dam, where the discharge of the river is controlled by gates, except during flood stages. The gates are closed on Sundays, and, except at high stages, no water is allowed to pass. The measurements are made by Mr. Alexander H. Twombly, engineer of the Forest Paper Company, at Yarmouthville, Me., who has kindly furnished the figures for publication.

Daily discharge, in second-feet, of Cobbosseecontee River at reservoir dam, near Augusta, Me., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	240	220	120	535	260	510	280	280	(a)	273	250	(a)
2	240	220	120	439	260	483	280	280	280	270	250	220
3	250	(a)	(a)	646	260	439	280	280	280	250	(a)	220
4	250	220	120	1,439	260	303	(a)	(a)	280	250	250	220
5	250	220	120	2,118	(a)	303	280	280	280	250	250	220
6	(a)	220	120	2,343	260	304	280	280	280	(a)	250	220
7	250	220	120	2,089	260	300	(a)	280	280	250	250	220
8	250	220	120	3,111	280	300	280	280	(a)	250	250	(a)
9	250	220	120	3,205	280	280	280	280	280	250	250	220
10	250	(a)	(a)	3,050	280	280	280	280	280	250	(a)	220
11	240	200	130	2,872	280	280	280	(a)	280	250	250	220
12	240	200	170	2,649	(a)	280	280	280	280	250	250	220
13	(a)	200	200	2,580	280	280	280	280	280	(a)	250	220
14	220	200	220	2,534	280	280	(a)	280	270	250	250	220
15	220	180	220	2,339	280	280	280	280	(a)	250	250	(a)
16	220	180	220	2,213	280	(a)	280	280	270	250	250	2,700
17	220	(a)	(a)	2,089	280	280	280	280	270	250	(a)	2,600
18	220	125	220	2,034	280	280	280	(a)	270	250	250	1,143
19	220	125	220	1,921	(a)	280	280	280	270	250	250	999
20	(a)	125	220	1,756	280	280	280	280	270	(a)	250	270
21	220	125	220	1,143	280	280	(a)	280	270	250	250	270
22	220	125	250	999	280	280	280	280	(a)	250	250	(a)
23	220	125	250	1,194	280	280	280	280	270	250	250	270
24	220	(a)	(a)	1,296	280	280	280	280	270	250	(a)	270
25	220	125	276	1,194	280	280	280	(a)	270	250	250	270
26	220	125	524	1,046	26	280	280	280	270	250	250	270
27	(a)	120	919	907	286	280	280	280	270	(a)	220	270
28	220	120	1,404	1,109	286	280	280	280	270	250	(a)	270
29	220		1,262	985	354	280	280	280	(a)	250	220	(a)
30	220		824	260	393	(a)	280	280	270	250	220	284
31	220		569		483		280	280		250		1,143
Mean	231	173	344	2,046	290	306	280	280	274	252	246	526

[a] Water shut back on Sundays and holidays when under control.

ANDROSCOGGIN RIVER AT RUMFORD FALLS, ME.

The discharge of the Androscoggin River at Rumford Falls since 1892 has been computed by Mr. Charles A. Mixer, resident engineer of the Rumford Falls Power Company. These figures have been published from time to time by the Survey, and a complete record to date will be found in Water-Supply Paper No. 69.

The following table gives the record for the year 1901:

Daily discharge, in second-feet, of Androscoggin River at Rumford Falls, Me., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1,872	1,827	1,940	2,887	16,128	6,712	3,355	3,053	1,812	1,696	1,741	1,525
2	1,757	1,826	1,926	3,200	15,173	6,453	3,192	3,024	1,852	1,715	1,605	1,427
3	1,692	1,837	1,934	3,882	14,297	7,223	3,584	2,899	1,721	1,671	1,563	1,563
4	1,872	1,683	2,081	6,303	13,977	7,424	3,670	2,525	1,624	1,725	1,499	1,403
5	1,811	1,641	2,124	8,823	12,634	6,725	3,099	2,941	1,671	1,670	1,600	1,209
6	1,901	1,644	2,087	8,328	11,614	6,051	2,681	2,490	1,643	1,547	1,677	1,340
7	1,890	1,595	2,061	13,694	10,610	5,634	2,850	3,547	1,418	1,768	1,666	1,307
8	2,015	1,563	2,094	17,062	9,472	6,916	3,209	5,035	1,447	2,031	1,649	1,383
9	1,974	1,653	2,191	17,115	8,608	5,909	3,500	4,615	1,518	2,021	1,589	1,390
10	1,908	1,660	2,223	15,115	8,503	5,766	3,432	2,997	1,374	2,060	1,588	1,609
11	1,856	1,764	2,055	15,956	16,044	5,510	3,116	3,377	1,449	1,982	1,576	2,021
12	1,896	2,496	2,070	14,911	16,507	4,598	3,445	3,189	1,609	1,641	1,767	2,087
13	1,935	2,054	2,113	12,811	12,362	3,755	3,120	2,927	1,631	1,705	1,787	1,989
14	1,938	1,949	2,011	12,831	12,068	3,680	1,992	2,802	1,537	3,536	1,829	2,616
15	1,896	1,765	1,961	14,285	10,868	3,450	1,739	2,693	1,442	5,137	1,814	27,785
16	1,956	1,868	1,889	13,694	9,871	3,206	1,784	3,244	1,764	3,818	1,748	22,578
17	2,082	1,885	1,934	13,580	8,854	3,271	2,039	3,135	1,742	2,911	1,640	6,243
18	2,026	1,912	1,943	15,139	8,054	3,040	2,842	2,116	1,666	2,860	1,702	3,515
19	1,833	1,985	1,938	15,181	10,924	2,926	2,833	2,118	1,611	2,859	1,700	2,865
20	1,895	1,969	1,873	14,576	16,808	2,992	2,675	2,453	1,440	2,689	1,692	2,597
21	1,907	1,875	1,980	19,219	11,722	3,584	2,428	2,782	1,521	2,866	1,592	2,473
22	2,002	1,842	2,861	32,653	9,310	3,227	2,054	2,750	1,416	2,640	1,636	2,310
23	1,925	1,855	3,407	30,619	8,186	3,227	1,824	2,682	1,955	2,222	1,637	2,298
24	1,881	1,853	3,046	23,886	7,578	3,297	1,864	2,498	1,787	1,749	1,532	2,518
25	1,917	1,822	2,865	19,065	8,046	3,419	1,822	2,499	1,535	1,803	1,543	2,436
26	1,886	1,776	3,114	18,371	6,711	3,100	1,739	2,443	1,682	1,736	1,425	2,506
27	1,898	1,848	3,720	16,162	6,285	2,831	1,612	2,287	1,343	1,728	1,361	2,528
28	1,858	1,856	4,445	16,062	7,300	2,787	1,844	2,166	1,361	1,770	1,233	2,948
29	1,835		3,845	15,198	8,464	2,868	2,239	2,114	1,489	1,873	1,205	2,643
30	1,823		3,378	16,120	7,910	3,033	3,381	2,090	1,652	1,755	1,590	2,761
31	1,800		3,234		8,248		3,833	1,925		1,753		2,813
Mean	1,895	1,832	2,463	14,891	10,714	4,420	2,671	2,788	1,590	2,224	1,606	3,441

PRESUMPSCOT RIVER AT OUTLET OF SEBAGO LAKE, MAINE.

Since January, 1887, the flow from Sebago Lake has been measured, the quantity being deduced from the openings in the regulating gates at the dam, the discharging capacity of which, under different conditions of head, has been determined and tabulated by Mr. Hiram F. Mills, of Lowell. The results of these measurements have been furnished by Messrs. S. D. Warren & Co. The drainage area at the point of measurement is 470 square miles, of which about 60 square miles are lake surface. The basin is described in the Nineteenth Annual Report, Part IV, and in Water-Supply Paper No. 69, where records for former years are given.

The following table gives the record for 1901:

Daily discharge, in second-feet, of Presumpscot River at outlet of Sebago Lake, Maine, for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	647	673	667	538	673	728	747	693	300	650	630	267
2	647	673	667	538	673	466	747	693	653	650	630	697
3	647	550	550	538	673	993	747	693	653	650	283	697
4	647	667	693	538	673	993	747	300	653	650	717	697
5	647	667	693	538	333	993	747	693	653	650	717	697
6	367	667	693	538	683	993	747	693	653	283	717	697
7	643	667	693	367	683	993	400	693	653	647	717	697
8	643	667	693	0	683	993	713	693	300	647	717	267
9	643	667	693	0	683	466	713	693	642	647	717	700
10	643	550	567	15	333	795	713	693	642	647	283	700
11	643	660	833	175	333	795	713	300	642	647	667	700
12	643	660	733	175	333	795	713	520	642	647	667	700
13	367	660	467	175	693	795	713	520	642	283	667	700
14	641	660	467	300	693	795	400	520	642	317	667	700
15	641	660	583	633	693	795	707	520	300	317	667	200
16	641	660	667	633	693	450	707	520	667	317	667	583
17	641	517	333	633	693	712	707	520	667	643	233	583
18	641	673	733	633	693	712	707	300	667	643	663	700
19	641	673	733	633	333	712	707	543	667	643	663	700
20	641	673	733	633	708	712	707	543	667	283	663	700
21	637	673	733	300	700	712	400	543	667	687	663	700
22	637	673	500	500	708	712	700	543	300	687	663	200
23	637	673	500	333	708	400	700	543	658	687	663	700
24	637	550	333	333	350	623	700	543	658	687	267	700
25	637	667	683	333	350	623	700	300	658	687	657	700
26	637	667	683	667	333	623	700	662	658	687	657	700
27	367	667	683	667	728	623	700	662	658	283	657	700
28	673	667	683	333	728	623	300	662	658	630	657	700
29	673	.....	683	673	728	623	693	662	300	630	657	700
30	673	.....	683	673	728	400	693	662	650	630	657	700
31	673	.....	367	.....	728	.....	693	662	.....	630	.....	700
Mean	619	649	623	466	605	722	670	575	596	574	618	616

OTHER NEW ENGLAND RIVERS.

MERRIMAC RIVER AT LAWRENCE, MASS.

Records of flow of this river at Lawrence have been kept for more than fifty years, but have never been published in full. Figures for the monthly maximum and minimum discharge from 1890 to 1897 were published in the Nineteenth Annual Report, Part IV; the daily discharge for 1897, 1898, and 1899 in Water-Supply Paper No. 35; the daily discharge for 1900 in Water-Supply Paper No. 47. These figures are furnished by Mr. R. A. Hale, engineer of the Essex Water Power Company.

SOUTH BRANCH OF NASHUA RIVER AT CLINTON, MASS.

Since July, 1896, the flow of the South Branch of Nashua River has been measured at Clinton, Mass., by the Metropolitan water board. The results of these measurements have been furnished by Mr. Frederic P. Stearns, chief engineer. Beginning with 1897 the flow has been corrected for loss and gain of storage in ponds and mill reservoirs on the watershed, so that the results show the natural flow of the stream. The flow for 1896, however, has not been corrected for storage. The tables, as furnished to the Survey, gave the flow in

million gallons a month. These results have been reduced to second-feet, and the run-off in inches on drainage area and in second-feet per square mile has been computed.

The following extract from the Annual Report of the Metropolitan Water and Sewage Board for the year 1901 will explain more in detail the method of making the gagings at Clinton:

The gagings are intended to show the quantity of water that would have flowed past the gaging station if no water had been diverted through the Wachusett aqueduct, and for nearly all of the time the quantity that would have flowed if there had been no mill and other storage reservoirs upon the watershed.

As accurate gagings of streams are rare, it is thought desirable to describe in some detail the methods of measurement.

The quantity of water passing down the river bed has been gaged at a point near the Water Street bridge in Clinton. Just above this bridge there is an unused dam which has been partly demolished, but at which there is still a decided fall, so that the height of the water above it, when a given quantity of water is flowing, is affected but little, if any, under all ordinary conditions by the condition of the stream below the dam as regards obstructions from weeds in summer and ice in winter.

Above this dam a recording float gage was established to give the height of the water accurately and continuously. Just below the dam and bridge a gaging section was established having a plank bottom and so arranged that the velocity is sufficient for accurate current meter gagings. When the flow of the river is very small, owing to the diversion of the water through the aqueduct, arrangements have been made to diminish the width of the section through which the water flows and thereby produce a sufficient depth and current for meter measurement.

By a sufficient number of meter measurements at all stages of the river a curve was determined which showed the quantity of water corresponding to all heights on the recording gage. The relation between the quantity and the gaged height is frequently checked throughout the year.

The current meter used was originally rated and the rating has since been checked from time to time at a well-arranged rating apparatus at Sandy Pond.

From July 1, when the gagings were begun, to July 15, the recording gage was not in operation, but an average of 8 observations of height was made daily. In February, 1900, on account of a great flood which overflowed the bank of the river where the gage house and gage were located, it became necessary to remove the gaging apparatus and there were two days when the heights were not kept continuously throughout the twenty-four hours. Otherwise the recording gage has been in continuous operation.

The first diversion of water from the river through the aqueduct was on March 7, 1898. At the lower end of the aqueduct a weir was established with a recording float gage, providing for a continuous record of the height of water flowing over the weir. A current-meter station was established for gaging the flow through the aqueduct and the weir was calibrated by many measurements with the current meter at various depths of flow. The quantity of water flowing through the aqueduct is, therefore, very accurately measured. In the lower stages of the river nearly all of the water passes through the aqueduct.

There are upon the watersheds fourteen storage ponds and reservoirs, nearly all controlled by the mills, the capacities of which have been determined. The draft from these reservoirs materially increases the flow of the river in the drier portions of the year and the flow diminishes while they are filling. The total capacity of the reservoirs is 1,471,800,000 gallons.

Observations of the heights of water in the reservoirs included in the table have been taken twice each month, usually on the 1st and 15th days, during the following periods: June 1, 1897, to November 15, 1897, inclusive; June 1, 1898, to November 1, 1898, inclusive; June 1, 1899, to January 15, 1900, inclusive; and continuously since June 1, 1900.

No observations of the heights of reservoirs were taken in 1896, nor were any taken during the winter and spring months until after the spring of 1900. The omission of the observations of the storage reservoirs in the summer and autumn of 1896 materially affects the records for that period, but the omission of observations in the winter and spring of several years causes little or no error, because at such times the reservoirs are usually full or nearly full and the flow of the stream is comparatively large.

As already indicated, the aggregate quantity flowing in the river at the gaging station and in the aqueduct is corrected for the amount drawn from or added to storage, so that the records give as nearly as possible the actual flow of the river as it would be in its natural condition.

The change in storage during the month preceding and following the observed heights has been estimated, and during the remainder of the winter and spring months, when there were no observations, it has been assumed that the reservoirs were full.

The area of the watershed above the Wachusett dam was determined by the State board of health from the topographical map of the State, after a careful reconnoissance of the divide for its whole length, to be 118.23 square miles. A change in the location of the north dike from that originally proposed has added 0.08 of a square mile, and an additional area of 0.69 of a square mile draining to the river between the Wachusett dam and the gaging station, makes the total area of the watershed at the gaging station 119 square miles.

Estimated monthly discharge of South Branch of Nashua River at Clinton, Mass.

[Drainage area, 119 square miles.]

Month.	Mean discharge.	Run-off.		Rainfall.
		Per square mile.	Depth.	
1896.[a]	*Second-feet.*	*Second-feet.*	*Inches.*	*Inches.*
July	62	0.519	0.599	4.74
August	56	.467	.539	2.62
September	84	.707	.788	7.31
October	146	1.228	1.415	3.72
November	168	1.410	1.572	2.99
December	172	1.447	1.668	2.22
1897.				
January	147	1.232	1.420	3.46
February	171	1.440	1.500	2.86
March	508	4.270	4.922	4.01
April	300	2.525	2.818	2.32
May	214	1.800	2.075	5.06
June	217	1.828	2.039	5.11
July	266	2.231	2.572	8.65
August	165	1.386	1.599	3.47
September	70	.588	.656	1.93
October	45	.377	.434	.94
November	236	1.984	2.214	7.62
December	419	3.521	4.059	6.41
The year	230	1.938	26.308	51.84

[a] Figures for 1896 have not been corrected for loss and gain by storage in ponds and mill reservoirs.

Estimated monthly discharge of South Branch of Nashua River at Clinton, Mass.—Continued.

Month	Mean discharge.	Run-off.		Rainfall.
		Per square mile.	Depth.	
1898.	*Second-feet.*	*Second-feet.*	*Inches.*	*Inches.*
January	288	2.418	2.787	6.65
February	301	2.530	2.635	3.30
March	569	4.778	5.509	2.27
April	374	3.137	3.500	4.43
May	256	2.151	2.480	3.38
June	153	1.281	1.429	3.11
July	61	.514	.593	3.01
August	244	2.049	2.363	10.61
September	124	1.045	1.166	3.15
October	278	2.334	2.691	7.21
November	400	3.358	3.746	6.81
December	380	3.189	3.676	3.99
The year	286	2.400	32.575	57.92
1899.				
January	385	3.236	3.731	2.93
February	201	1.687	1.757	5.12
March	511	4.295	4.952	6.75
April	622	5.224	5.829	1.94
May	159	1.334	1.538	1.33
June	103	.869	.969	5.51
July	65	.548	.631	3.82
August	43	.365	.421	3.20
September	46	.387	.431	4.11
October	45	.379	.437	2.72
November	79	.665	.742	1.94
December	66	.555	.640	2.03
The year	194	1.626	22.078	41.40
1900.				
January	147	1.232	1.420	4.56
February	747	6.271	6.532	8.69
March	686	5.759	6.639	6.19
April	291	2.444	2.727	2.76
May	255	2.139	2.467	4.34
June	106	.894	.998	3.59
July	40	.336	.388	3.20
August	36	.304	.351	3.18
September	23	.197	.220	3.46
October	52	.437	.504	2.90
November	161	1.354	1.510	6.44
December	289	2.429	2.800	3.15
The year	233	1.956	26.556	52.46
1901.				
January	96	.803	.926	1.75
February	66	.551	.574	1.13
March	501	4.205	4.849	5.82
April	919	7.711	8.605	9.64
May	503	4.222	4.867	7.02
June	182	1.525	1.701	1.51
July	88	.738	.851	5.66
August	94	.792	.913	4.58
September	59	.495	.552	3.10
October	119	1.001	1.154	3.70
November	95	.799	.892	2.43
December	596	5.002	5.766	9.36
The year	277	2.332	31.650	55.70

SUDBURY RIVER AND LAKE COCHITUATE, MASSACHUSETTS.

Sudbury River and Lake Cochituate have been studied by the engineers of the city of Boston, the State board of health of Massachusetts, and the Metropolitan water board, and records of rainfall in the Sudbury watershed have been kept since 1875, in the Cochituate basin since 1852, but the latter have been considered of doubtful accuracy previous to 1872. The records of run-off from 1875 to 1898, inclusive, were published in the Twentieth Annual Report, Part IV, those of 1899 in Water-Supply Paper No. 35, and those of 1900 in Water-Supply Paper No. 47. The following table gives the record for 1901. All of the records were furnished by Mr. Desmond Fitz Gerald.

Run-off and rainfall for Sudbury River watershed, Massachusetts, for 1901.

[Drainage area, 75.2 square miles.]

Month.	Run-off per square mile.	Depth of run-off.	Rainfall.	Percentage of rainfall collected.
	Second-feet.	*Inches.*	*Inches.*	
January	0.676	0.779	1.82	42.7
February	.464	.483	1.52	31.7
March	4.262	4.912	6.57	74.8
April	6.504	7.257	8.60	84.4
May	4.570	5.269	7.23	72.9
June	1.165	1.299	1.38	94.1
July	.473	.545	5.71	9.6
August	.655	.756	4.57	16.5
September	.473	.527	3.30	16.0
October	.637	.734	2.82	26.1
November	.734	.819	2.90	28.3
December	4.170	4.808	9.69	49.6
Year	2.076	28.188	56.11	50.2

Run-off and rainfall for Lake Cochituate watershed, Massachusetts, for 1901.

[Drainage area, 18.87 square miles.]

Month.	Run-off per square mile.	Depth of run-off.	Rainfall.	Percentage of rainfall collected.
	Second-feet.	*Inches.*	*Inches.*	
January	0.840	0.968	1.85	52.3
February	.629	.655	1.80	36.4
March	3.845	4.434	6.35	69.8
April	4.649	5.187	7.51	69.1
May	3.704	4.269	6.93	61.6
June	1.019	1.137	1.26	90.2
July	.792	.913	6.67	13.7
August	1.101	1.269	4.48	28.3
September	1.012	1.129	3.17	35.6
October	1.083	1.249	2.83	44.1
November	1.034	1.154	3.03	38.1
December	3.675	4.237	8.58	49.4
Year	1.959	26.601	54.46	48.8

MYSTIC LAKE, MASSACHUSETTS.

This lake was formerly a source of water supply for the city of Charlestown, Mass. A brief description of the watershed is given in Water-Supply Paper No. 35; also the run-off in inches from the watershed from 1878 to 1897, inclusive.

BLACKSTONE RIVER AT BERKELEY, R. I.

The Blackstone River, rising in Massachusetts and flowing to tide water at Providence, R. I., is one of the great water-power rivers of the United States. Its flow is largely affected by the many dams built across the river for the development of water power. A station for systematically measuring the flow of the Blackstone was established in May, 1901, by John E. Hill, professor of civil engineering, Brown University, and measurements of flow have been made under his charge by two students of the university, George H. Gilbert and Henry B. Drowne. The station is located at a bridge about one-fifth of a mile west of the New York, New Haven and Hartford Railroad station at Berkeley. The drainage area at this point is 429 square miles. At this point the Blackstone River is paralleled by Blackstone canal, and measurements of the canal are usually made immediately after the measurements of the river are completed. The canal begins at the Ashton dam, three-fourths of a mile upstream, and terminates at the Lonsdale mills, 2 miles below the station. Throughout the late spring and summer the gates at Lonsdale are closed at 12.30 p. m. on Saturdays. The combined flow of the river and canal represents the total flow from the drainage area of the Blackstone above Berkeley. The gagings are made from bridges over the river and canal. The gages are vertical rods nailed to the bridges, the river gage being referred to two bench marks—the first is a large stone 20 feet south of road, 90 feet east of bridge, and 12 feet southwest of old oak tree, the elevation being 8.87 feet; the second is the west end of stone doorsill to office of Berkeley Mills; elevation, 18 feet. There are two benches for the canal gage, the first being the top of the same stone as used for the river gage, its elevation being 2.10 feet below the zero of the gage rod, while the stone sill just described has an elevation of 7.03 feet. The banks of both the river and canal are high, the river having a straight course above the station, though slightly curved below. The gages were read twice a day, 7.30 a. m. and 4.30 p. m., by Joseph A. Ray, master mechanic in the Berkeley Mills, from May 17 to August 17, and since September 22 by A. E. Glover, station agent, New York, New Haven and Hartford Railroad.

The following measurements were made during the year 1901:

Discharge measurements of Blackstone River at Berkeley, R. I.

Date.	Hydrographer.	Gage height.	Discharge.
1901.		*Feet.*	*Second-feet.*
June 20	Geo. H. Gilbert	3.80	464
July 14	do	3.72	342
Sept. 17	Henry B. Drowne	3.92	773
Oct. 26	Geo. H. Gilbert	3.92	[a] 88

[a] Saturday p. m.: Small discharge probably due to closing of gates at Ashton and Lonsdale.

Discharge measurements of Blackstone canal at Berkeley, R. I.

Date.	Hydrographer.	Gage height.	Discharge.
1901.		*Feet.*	*Second-feet.*
June 20	Geo. H. Gilbert	2.70	230
June 29			
a. m.			
6.35–7.06	Geo. H. Gilbert	2.76	100
7.40–8.26	do	2.58	145
9–9.45	do	2.54	195
11–11.37	do	2.56	259
p. m.			
12.50–1.35	Geo. H. Gilbert	2.32	134
Sept. 17	do	2.70	224
Nov. 15	do	2.32	88

Daily gage height, in feet, of Blackstone River near Berkeley, R. I., for 1901.

Day	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1		4.05	3.70	3.90		4.05	3.85	4.05
2		3.75	3.65	3.80		4.05	3.90	3.90
3		4.05	3.45	4.00		4.15	3.90	4.15
4		4.15				3.90	3.85	4.15
5		4.00	3.45	3.65		3.85	3.85	4.25
6		4.00	3.80	3.80		3.65	3.90	4.25
7				3.65		3.90	3.70	4.20
8		3.65	3.95	3.95		3.90	3.75	4.00
9			3.65	3.80		4.00	3.90	3.95
10		3.80	3.25	3.80		3.85	3.90	4.30
11		4.00	3.55			3.90	3.85	4.35
12		4.10	4.05	3.60		3.90	3.80	4.35
13		4.00	4.00	3.65		4.10	3.70	4.35
14		4.15		3.60		4.00	3.65	4.40
15		4.20	3.70	3.55		4.00	3.70	4.40
16			3.80	3.55		4.00	3.75	6.10
17	3.95	4.10	3.60	3.80		4.10	4.00	4.85
18	3.65	3.45	3.65	[a]		4.10	3.85	4.55
19	4.10	3.75	3.55			4.05	3.90	4.30
20	5.05	4.25	3.90			3.60	3.70	4.30
21	4.80	3.90				3.90	3.80	4.50
22	4.35	4.50	3.75			3.90	3.80	4.50
23	4.20		3.40		3.90	4.00	3.75	4.50
24	4.15	3.80	3.45		3.90	3.90	4.00	4.40
25	4.25	3.95	3.65		3.90	4.00	4.00	4.20
26	4.00	4.00	3.85		3.80	3.90	4.00	4.20
27	4.40	3.95	4.00		3.80	3.90	3.85	4.10
28	5.00	3.95			3.80	3.90	3.85	4.10
29	5.50	3.80	3.80		4.05	3.90	3.80	4.20
30	4.45		3.65		3.80	3.90	4.35	6.75
31	4.50		3.65			3.80		6.75

[a] No record Aug. 18 to Sept. 22, inclusive. The daily gage heights during that period were approximately 3.75.

Daily gage height, in feet, of Blackstone canal, near Berkeley, R. I., for 1901.

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1		3.20	2.65	2.85		2.70	2.75	3.30
2		3.25	2.35	2.55		2.85	2.90	2.85
3		2.85	2.25	3.00		2.70	2.85	2.80
4		2.75				2.85	2.70	2.90
5		2.70	2.60	2.45		2.80	2.70	2.95
6		2.80	2.50	2.50		3.25	2.65	2.95
7				2.40		2.85	2.80	3.10
8		2.95	2.50	2.55		2.70	2.75	3.00
9			2.35	2.80		2.70	2.70	2.90
10		2.65	2.15	2.90		2.70	3.40	3.10
11		2.70	2.80			2.80	2.75	3.10
12		2.65	2.75	2.60		2.90	2.60	3.00
13		2.75	3.00	2.70		3.20	2.55	2.95
14		2.80		2.35		2.95	2.45	3.15
15		2.80	2.75	2.25		2.80	2.50	3.60
16			2.65	2.55		3.00	2.85	4.45
17	2.70	2.80	2.50	2.80		2.80	3.30	3.00
18	2.85	2.45	2.60	(a)		2.85	2.70	3.10
19	3.20	2.80	2.55			2.80	2.90	3.00
20	3.35	2.95	2.90			3.35	2.65	3.00
21	3.20	2.65				2.90	2.30	3.20
22	3.10	2.70	2.50			2.70	2.85	3.20
23	2.85		2.45		2.90	2.80	2.75	3.20
24	2.75	2.65	2.20		2.90	2.65	3.35	3.10
25	3.20	2.80	2.35		2.80	2.75	2.90	3.15
26	3.45	2.85	2.65		2.60	2.75	3.10	3.05
27	2.85	2.75	2.80		2.60	3.35	2.95	3.00
28	3.55	3.80			2.60	2.75	3.10	3.00
29	3.55	2.60	2.50		3.05	2.70	2.85	3.70
30	3.05		2.40		2.85	2.85	3.20	3.50
31	3.20		2.40			2.85		3.00

[a] No readings Aug. 17–Sept. 22, inclusive.

CONNECTICUT RIVER AT ORFORD, N. H.

This river rises in Connecticut Lake in the northern portion of New Hampshire. A gaging station was established August 6, 1900, by E. G. Paul, on the covered highway bridge over the river between Orford, N. H., and Fairlee, Vt. This station is described in Water-Supply Paper No. 47, where the results of observations during 1900 are given. The following measurements were made during 1901 by Mr. Charles A. Holden, of Dartmouth College:

Discharge measurements of Connecticut River at Orford, N. H.

Date.	Hydrographer.	Gage height.	Discharge.
1901.		*Feet.*	*Second-feet.*
April 15	Charles A. Holden	17.4	[a] 16,967
June 22	do	6.80	4,244
Oct. 5	do	3.47	1,458
Nov. 2	do	3.67	1,591

[a] Estimated.

Daily gage height, in feet, of Connecticut River at Orford, N. H., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	[a]8.20	(b)	(b)	12.65	14.45	9.50	10.10	8.40	3.00	3.40	3.90	3.60
2	[a]8.00	[a]5.80	[a]5.80	11.85	14.80	9.00	8.80	8.00	3.80	3.40	3.90	3.70
3	(b)	(b)	(b)	12.60	14.35	8.20	6.20	6.40	4.00	3.50	3.80	3.80
4	(b)	(b)	(b)	15.45	13.15	8.40	7.40	6.00	4.00	3.50	4.40	(b)
5	[a]7.00	(b)	(b)	17.80	11.80	8.80	7.60	5.70	3.80	3.60	3.60	(b)
6	(b)	(b)	(b)	17.65	10.70	8.80	8.20	5.60	3.50	3.90	3.40	(b)
7	(b)	(b)	(b)	18.80	9.75	8.60	6.80	5.30	3.50	4.20	3.40	[a]4.00
8	[a]6.00	(b)	(b)	21.45	9.35	7.85	6.70	6.20	3.50	4.00	3.30	(b)
9	(b)	[a]5.90	[a]6.00	22.40	9.10	8.45	6.50	6.90	4.20	3.70	3.40	(b)
10	(b)	(b)	(b)	21.95	9.10	8.50	6.80	8.10	3.60	3.70	3.50	(b)
11	(b)	(b)	(b)	20.80	9.40	8.20	6.60	8.80	3.50	3.60	4.00	(b)
12	[a]5.90	(b)	(b)	19.35	9.75	8.00	6.50	8.70	3.40	3.60	3.80	[a]7.00
13	(b)	(b)	(b)	18.20	9.95	7.70	6.50	8.60	3.60	3.50	3.40	7.60
14	(b)	(b)	(b)	17.45	10.00	7.00	5.70	7.60	3.80	4.20	4.00	8.00
15	(b)	(b)	(b)	17.35	9.65	6.50	4.60	6.70	4.00	4.60	4.40	13.00
16	(b)	[a]5.80	[a]6.40	17.60	8.60	6.20	4.10	6.10	4.40	7.10	4.40	21.70
17	(b)	(b)	(b)	17.80	7.90	6.00	4.00	6.80	3.80	7.60	4.50	20.80
18	(b)	(b)	(b)	18.00	8.05	5.80	3.90	6.80	3.70	6.00	4.80	16.90
19	[a]5.80	(b)	(b)	18.40	9.00	5.30	5.00	6.60	3.90	5.90	4.60	14.70
20	(b)	(b)	(b)	18.75	10.60	5.20	5.05	6.40	4.10	5.60	4.10	10.20
21	(b)	(b)	(b)	18.80	12.15	5.10	5.00	6.40	4.10	5.50	3.90	8.40
22	(b)	(b)	(b)	19.65	10.05	6.75	4.70	5.20	4.20	5.30	3.50	8.80
23	(b)	[a]5.80	[a]7.20	21.35	9.55	7.40	4.30	5.00	4.50	5.10	3.50	9.20
24	(b)	(b)	(b)	22.55	9.50	8.70	4.00	4.80	4.20	4.90	3.70	(b)
25	(b)	(b)	10.70	22.70	10.60	8.95	3.90	4.70	3.60	4.70	4.30	(b)
26	[a]5.80	(b)	11.70	21.35	10.80	8.30	3.50	4.60	3.50	4.50	4.40	(b)
27	(b)	(b)	14.60	19.05	9.75	7.20	3.30	4.10	3.30	4.90	4.50	(b)
28	(b)	(b)	17.40	16.65	9.50	6.30	3.55	3.80	3.30	5.00	4.30	(b)
29	(b)		16.50	14.95	10.05	6.75	4.15	3.50	3.20	4.80	3.70	(b)
30	(b)		14.70	14.05	10.60	9.50	4.90	3.40	3.90	4.30	3.70	9.40
31	(b)		13.40		10.50		7.40	3.00		4.00		(b)

[a] Through the ice. [b] Frozen.

CONNECTICUT RIVER AT HOLYOKE, MASS.

Measurements have been made of the flow of the Connecticut River at Holyoke for many years. For record see Water-Supply Paper No. 35. The figures have been furnished by Mr. A. F. Sickman, assistant engineer of the Holyoke Water Power Company. Records have not been kept during 1900 and 1901.

CONNECTICUT RIVER NEAR HARTFORD, CONN.

Observations of the height of Connecticut River near Hartford are made by the Connecticut River bridge and highway district, Edwin Dwight Graves, chief engineer, as noted in the Twentieth Annual Report, Part IV, page 77. The zero of the gage corresponds with the zero of the original gage used as the datum for the surveys of the Connecticut River in 1872 to 1878, by the Corps of Engineers, U. S. Army. (See report of Maj. Gen. G. K. Warren of surveys made by Gen. Theodore G. Ellis, published in the report of the Chief of Engineers, 1878, Part I, pages 246-391.) This same datum has been used by all the United States Army engineers in work upon the Connecticut River down to the present time.

Daily readings from 1896 to 1899 were published in Water-Supply Paper No. 35, pages 42 to 44. The record for 1900 was published in Water-Supply Paper No. 47, page 35.

In the following table will be found the gage heights for 1901:

Daily gage height, in feet, of Connecticut River at Hartford, Conn., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	5.0	3.3	2.5	10.5	13.3	13.5	3.1	2.8	2.5	3.4	2.9	2.6
2	4.8	3.2	2.8	9.5	12.5	11.8	3.1	3.0	2.8	3.3	2.5	2.5
3	4.0	.....	.....	9.6	12.3	10.8	4.1	3.8	4.8	3.3	2.8	2.8
4	4.8	2.5	2.5	12.2	12.3	9.6	4.0	3.8	4.3	3.6	3.0	2.2
5	4.8	3.7	3.5	14.8	11.6	8.6	3.5	3.5	3.6	3.5	3.9	3.3
6	.....	3.2	3.5	16.0	10.5	8.0	3.5	3.3	3.5	2.8	3.5	3.5
7	4.4	3.0	3.0	19.3	9.5	7.5	3.8	4.3	3.4	3.0	3.4	3.5
8	4.3	2.8	3.3	23.9	8.5	7.3	4.5	5.0	2.8	3.6	3.5	3.0
9	4.2	3.0	3.5	26.4	8.0	7.4	4.3	5.8	2.7	3.3	3.3	3.4
10	3.8	.....	.....	25.8	7.4	7.2	4.1	5.8	3.5	3.2	1.1	4.6
11	4.2	1.8	5.3	23.7	8.8	6.8	3.7	5.3	4.0	3.0	0.3	5.0
12	4.7	3.2	9.3	21.3	10.8	6.6	4.2	5.0	3.3	2.8	2.4	6.0
13	.....	3.3	7.5	19.8	10.3	6.2	4.3	5.0	3.0	2.5	2.8	5.9
14	4.3	3.3	5.8	18.0	9.8	5.8	3.8	4.8	2.6	2.5	2.4	5.7
15	4.4	3.2	5.5	17.3	9.3	5.5	3.3	4.3	2.3	8.3	3.1	12.0
16	4.5	3.3	5.2	16.5	8.4	5.2	3.1	4.0	2.5	9.0	3.0	19.8
17	4.8	.....	.....	15.8	7.8	4.5	3.0	3.8	2.8	7.8	2.6	20.0
18	4.5	2.8	4.1	15.3	7.2	4.3	3.0	4.0	3.3	6.7	2.9	18.0
19	.....	3.5	4.3	15.3	9.5	4.1	3.0	4.2	3.3	5.8	3.2	15.0
20	.....	3.5	4.0	15.2	13.3	3.9	2.9	4.3	3.4	5.0	3.0	11.5
21	3.8	3.3	5.0	15.3	19.3	3.6	2.4	4.3	3.3	4.8	3.1	8.6
22	4.3	3.3	12.2	21.7	13.8	3.8	2.8	4.5	2.4	4.5	3.3	6.5
23	4.3	3.4	12.6	23.0	12.3	3.3	2.8	4.5	3.0	4.3	3.3	8.5
24	4.2	3.3	10.3	22.3	11.1	4.2	3.0	4.0	3.4	4.2	4.1	9.2
25	4.4	2.0	10.3	21.5	12.0	4.5	3.3	4.8	3.6	4.3	3.8	8.3
26	4.0	3.2	10.3	22.2	12.2	4.1	3.0	6.0	3.7	3.5	3.4	5.7
27	.....	3.5	14.5	21.5	12.7	4.3	3.3	5.3	3.5	2.9	2.4	5.5
28	4.2	2.8	16.7	19.3	11.8	4.2	2.8	4.4	3.0	2.6	1.8	5.1
29	4.0	.....	16.3	17.1	14.3	4.2	2.6	3.8	3.0	2.9	2.8	6.6
30	4.0	.....	14.3	15.0	14.8	3.6	3.3	3.5	2.0	2.5	3.2	11.8
31	4.2	.....	12.0	.....	14.8	.....	3.0	3.0	.....	2.6	.....	14.5

ST. LAWRENCE DRAINAGE BASIN.[a]

St. Lawrence River receives the drainage from a number of important watersheds in northern New York. Its streams have their headwaters in the northwestern slope of the Adirondacks, where numerous lakes and ponds conserve a large portion of the naturally heavy precipitation.

There are five main streams, Oswegatchie, Grasse, Raquette, Salmon, and Chateaugay rivers, which flow in a northwesterly direction in courses more or less parallel. Important waterfalls occur in several of these streams near the points where they emerge from the Adirondacks, and fall over ledges of gneiss, sandstone, and granite onto the drift-filled plains below.

Oswegatchie and Raquette rivers are described in connection with gagings on these streams. Grasse River drains a long, narrow watershed lying intermediate between Oswegatchie and Raquette rivers. The channel of Grasse River is parallel to St. Lawrence River throughout the lower 18 miles of its course. For several miles of this distance it is separated from the St. Lawrence by a neck of land not exceeding 4 miles in width. Within this distance occurs the Long Sault Rapids of St. Lawrence River, comprising a fall of 45 to 50 feet. This fact has been taken advantage of for the construction of a great

[a] From report by R. E. Horton, resident hydrographer.

hydraulic power plant by the St. Lawrence Power Company. A canal 3½ miles in length has been cut across the divide opposite Massena by which water is diverted from near the head of Long Sault Rapids to a power plant situated on the bank of Grasse River; 35,000 horsepower is developed, under head of 42 feet. The spent water is turned into Grasse River, which is used as a tailrace.[a]

Owing to its lack of storage, water power on Grasse River is of less importance than on its neighboring streams, Oswegatchie and Raquette rivers. At Chase Mills a power exists giving a fall of 8 feet, which, it is stated, could be increased to 30 feet by the construction of a suitable dam, which would back water to the head of Chamberlain Rapids, some distance upstream. Below Russell an undeveloped power exists where a fall of 25 feet could be obtained.

Grasse River has a drainage area above Canton of 113 square miles, and of 637 square miles above its mouth. The stated high-water marks at Chase Mills indicate a maximum discharge of 4,700 second-feet in the spring of 1899. The drainage areas of other streams tributary to St. Lawrence River are given below:

Drainage areas of streams tributary to St. Lawrence River.

Stream.	Area.
	Sq. miles.
West Branch St. Regis River above junction of branches	280
East Branch St. Regis River above junction of branches	347
St. Regis River below junction of two branches	627
Deer River above junction with St. Regis River	212
St. Regis River above mouth	910
Little Salmon River above junction with Salmon River	103
Salmon River above Malone	179
Salmon River above Little Salmon River	273
Salmon River below junction with Little Salmon River	452
Salmon River above mouth	480
Trout River above New York State line	129
Chateaugay River above New York State line	199

[a] Full descriptions are given in Engineering News for February 21, 1901, pp. 130-132, and in a pamphlet entitled "The Saint Lawrence Power Company of Massena, New York," issued by the company.

Principal developed water powers on Grasse River.

No. of dam.	No. of mills at dam.	Location.	Head (in feet). Greatest.	Least.	Average.	No. of employees.	
1	3	Massena	8	7½	8	8	Gristmills and sawmills.
2	2	Lewisville	9	5	7	6	Gristmills and sawmills.
3	1	Chase Mills	8	8	8	2	Custom sawmill.
4	5	Madrid	9	5	7	57	Cloth mills, feed mills, and sawmills.
5	1	Bucks Bridge	9	8	8½	50	Sawmill.
6	4	Morley	8	3	6	8	Feed mill and wood-working mill.
7	4	Canton	12	6	9		Gristmills and sawmills, foundries, etc.
8	1	do					Sawmill.
9	1	Pyrites			65		Sulphite pulp mill.
10	2	Russell	10	6	8	8	Gristmills and wood-working mills, etc.

Water power on Little River.

1	1	Little River			12		Sawmills.
2	1	do			14	3	Gristmill and wood-working mill.
3	1	do			14		Gristmill.
4	1	do			12		

OSWEGATCHIE RIVER.

This stream has its source in a region of lakes and timbered swamps in southern St. Lawrence County. The largest of the lakes is Cranberry Lake, which affords valuable storage to water-power users on its outlet, east branch Oswegatchie River. The east and west branches flow in a general direction northwesterly. The two branches join near Talcville. From Gouverneur to Oxbow the river flows southwest; it then turns abruptly to the northwest. At Galilee it is joined by the outlet of Black Lake, and finally enters St. Lawrence River at Ogdensburg.

Drainage areas of Oswegatchie River.

Location.	Area.
	Sq. miles.
East branch Oswegatchie River above mouth	358
West branch Oswegatchie River above mouth	272
Oswegatchie River below junction of two branches	630
Oswegatchie River above Gouverneur	727
Oswegatchie River above Galilee	1,033
Indian River above Philadelphia	216
Black Lake watershed above Galilee	544
Oswegatchie River below Black Lake junction	1,577
Oswegatchie River above Ogdensburg	1,609

Cranberry Lake has a water-surface area of 12.8 square miles. Storage is developed by a federation of the water-power users below. Black Lake, having a water-surface area of 17.2 square miles, aids to regulate the flow at Ogdensburg. Opportunities for storage are presented on Indian River by Indian and Bonaparte lakes. Storage is maintained on Lake Bonaparte as a private enterprise, water-power users below paying for the use of the water during the dry season.

The first water power on the stream is at Ogdensburg. The dam is of timber, originally constructed in 1796. With the exception of the Ogdensburg city pumping station, on the right bank, power is transmitted to the mills through an open hydraulic canal. The power is partitioned into 101 privileges, of which 26 are termed first class and 75 second class. Of these, 62 are in use, this number including all the first-class privileges. In 1872 the supreme court was called upon to define the rights of the several claimants. A system of weirs with movable crests was established, one being placed at the entrance to each penstock. Over these weirs the water must pass in order to reach the turbines. The head is never allowed to go below 8 feet. During low water excessive draft is prevented by raising the weirs. The crests of the weirs for second-class privileges are kept 1.5 feet above those for first-class. A standard form of weir is used for all privileges, the weirs having a crest length of 4 feet.

One first-class privilege is accepted as being 32 second-feet under the existing head, or 29 horsepower theoretical, under the minimum head of 8 feet. The total power provided for is 754 theoretical horsepower. This would require a minimum flow of the stream of 928 second-feet.

The maximum reported high water of Oswegatchie River at Ogdensburg dam produced a depth of 5.5 feet on the crest of the dam, corresponding to an estimated discharge of 15,500 second-feet, or 9.6 second-feet per square mile.

At Heuvelton, above Black Lake inlet, the estimated discharge from the reported high-water marks is 9,019 second-feet, or 9.7 second-feet per square mile.

A current-meter measurement of the low-water flow of Oswegatchie River at Eel weir bridge, 6 miles above Ogdensburg, was made September 25, 1900. The discharge was found to be 614 second-feet, or 0.4 second-foot per square mile. At Heuvelton the measured discharge on September 26, 1900, was 804 second-feet, or 0.8 second-foot per square mile from the tributary drainage area of 1,027 square miles.

The discharge of Indian River at Town Line bridge, above Philadelphia, was 28.5 second-feet on September 28, 1900. On east branch Oswegatchie River, above Oswegatchie, are three undeveloped powers, capable of affording falls of 60, 20, and 20 feet, respectively, by the construction of low diverting dams on their crests.

Six miles above Harrisville, on middle branch Oswegatchie River, occurs a series of seven or eight falls, including Jerden and Kilburn falls. Among these is Sluice Falls, where the stream goes around a narrow headland in a narrow channel, having a nearly precipitous descent of about 100 feet.

At Rensselaer Falls, Oswegatchie and Grasse rivers are separated by a low-lying swampy plain draining in both directions through a so-called "natural canal."

Most of the powers of the Lower Oswegatchie watershed have been developed by the construction of timber dams on the crests of natural rifts, and there is very little opportunity for increasing the power except by centralizing the plants in single stations and installing more modern and highly efficient turbines.

At Gouverneur a natural fall of 3 feet over rocks has been increased to 8 feet by the construction of a dam. The mills are distributed in a row across the stream channel, each apparently being intended by the original partitioner to have the use of so much water as flowed over the section of the stream channel he occupies. Above Gouverneur the power is chiefly utilized for the pulverization of talc in the production of mineral fiber.[a]

At Theresa, on Indian River, power is developed under a head of 20 feet, capable of increase to 35 feet; similarly, at Philadelphia, on the same stream the existing head of 27.5 feet is capable of increase to 40 feet.

Principal developed water powers on Oswegatchie River.

No. of dam.	Number of mills at dam.	Location.	Head (in feet).			Number of employees.	
			Greatest.	Least.	Average.		
1	17	Ogdensburg	12	4	8	336	General manufacturing.
2	2	Henvelton	8	8	8	5	Woodworking mills and grist-mills.
3	3	Rensselaer Falls	8	7	7.5	31	Sawmills and custom mills.
4	1	Coopers Falls			8		Sawmill privileges.
5	4	Megatchie			11		Abandoned woolen mill. Sawmill; runs in winter.
6	1	Natural Dam			19.5	150	Sawmill and paper mill.
7	7	Gouverneur	9	4	7	82	General manufacturing.
8	1	Hailsboro					Talc pulp.
9	1	do					Do.
10	2	do			12	4	Woodworking mills. Custom grinding.
11	1	do			18		Talc pulp.
12	1	do			20	1	Oswegatchie Light and Power Co.
13	1	Emeryville			31	33	Gouverneur Wood Pulp Co.

[a] See The talc industry of St. Lawrence County, by C. H. Smyth, jr.: Report New York State Museum, Pt. II, 1895; pp. 661-671.

Principal developed water powers on Oswegatchie River—Continued.

No. of dam.	Number of mills at dam.	Location.	Head (in feet).			Number of employees.	
			Greatest.	Least.	Average.		
14	1	Dodgeville			16	11	U. S. Talc and Pulp Co.
15	1	Talcville			12	1	Talc mine.
16	2	Edwards			12	10	Gristmills and sawmills.
17		South Edwards					
18	1	Fine					Sawmills and paper mills.
19	1	Oswegatchie	38	30	34		Standard Pulp Co.
20	1	Newton Falls			20	150	Wood pulp.
21	1	do			38		Wood-pulp paper.

Water power on the west branch.

1	1	Below Fullerville			13	5	Talc pulp.
2	1	Fullerville			12		Ironworks (abandoned).
3	1	do			19.5	20	Wood and talc pulp.
4	1	Gears Corners	10	8	9		Sawmill (abandoned).
5	1	Harrisville			13	3	Grist mill.

RAQUETTE RIVER.

Raquette River drains a long, narrow watershed extending from northern Hamilton County to the St. Lawrence River. Above Piercefield the drainage basin broadens out, including a region interspersed with lakes and ponds, and affording ample opportunities for storage development.[a] The principal lakes of this region are the following:

Lakes in Raquette River Basin above Piercefield.

Lake.	Surface area.	Drainage area.
	Sq. miles.	*Sq. miles.*
Blue Mountain Lake[b]	3.9	39.26
Raquette Lake	8.3	93.9
Forked Lake	2.5	39.8
Long Lake	4.7	152.2
Little Tupper Lake	8.0	59.3

The upper plateau of Raquette River watershed is comparatively flat. Where the outflowing stream reaches the outcrop of granitic gneiss, forming the northwestern boundary line of the Adirondack region, it wears its way downward very slowly. From above Colton Falls to Hannawa Falls, a distance of 5 miles, a total fall of 385 feet occurs. With the exception of an old mill at its head, the upper portion of this fall is undeveloped.

[a] Described in report on A Survey of Upper Hudson and Raquette Rivers, by Farrand N. Benedict, 1872.

[b] Including Eagle and Utowana lakes.

Much of the fall occurs in passing a deep, narrow gorge, mostly in Potsdam sandstone, affording both excellent sites and material for dams. The most rapid descent is at Colton, where a fall of 100 feet occurs in a series of short cascades.

Going upstream, there are additional opportunities for power development at Higley Falls, South Colton Falls, and at Rainbow, Gaintwist, Leonard, Starks, Carry, and Raquette Falls. These latter are in the heart of the timbered region of the Adirondacks, and, lacking railroad facilities, are of little present importance. At Piercefield Falls, where the stream is crossed by the Adirondack division of the New York Central and Hudson River Railroad, is an important power development in connection with lumber industries.

Drainage areas of Raquette River.

Location.	Area.
	Sq. miles.
Above Piercefield	695
Above Hannawa Falls	967
Above Massena Springs	1,188
Above mouth	1,240

In connection with the development of water power at the lower descent of 84 feet at Hannawa Falls a gaging record has been established to determine the total flow of the stream past the dam and power plant. The dam is constructed of Potsdam red sandstone, with an ogee-shaped cross section. The length of the crest of the overflow is 234.5 feet. Water is carried along the top of the bluff at the right of the dam through an open earth canal 2,700 feet in length. The power canal terminates in a forebay, from which the water is conducted to the turbines in the power house at the foot of the cliff through 6-foot steel penstocks. The turbines are a specially built wheel of the Samson type, constructed by James Leffel & Co., of Springfield, Ohio, two runners being placed horizontally on the same shaft. The records kept for determining the volume of flow include depth flowing over spillway, the discharge through waste gates, and the water used to drive the turbines.

The pond formed by the dam affords a storage surface of about 200 acres.[a]

A current-meter measurement was made at Potsdam, N. Y., by Wallace C. Johnston August 28, 1898, which probably showed the extreme low-water flow of that year. The discharge was 755 second-feet. A current-meter measurement at Massena Springs highway bridge October 2–3, 1900, showed the low-water flow of Raquette River at that time to be 934 second-feet, or 0.78 second-foot per square mile.

Water power is being developed on Lower Raquette River at Nor-

[a] This plant is described in Engineering Record for December 7, 1901, pp. 546-549.

folk by carrying water around existing dams over a long rapid, so as to obtain a total fall of 32 feet. The power obtained will be used in the manufacture of paper. At Norwood a power exists where 8-foot head is now obtained, which could be redeveloped so as to afford a total fall of 25 feet, with extensive pond storage.

LAKE CHAMPLAIN OUTLET AT FORT MONTGOMERY, CLINTON COUNTY, N. Y.

Lake Champlain drains an area of 7,750 square miles, of which the major portion lies in the State of New York. The center line of the lake forms the boundary between New York and Vermont. The foot of the lake is situated at Rouse Point, near the Canadian boundary line. Richelieu River, the outlet of the lake, is 75 miles in length. It flows northerly across the Province of Quebec and enters St. Lawrence River at Sorel. The lake has a water-surface area of 437 square miles. It receives the drainage from the northeast slope of the Adirondacks. The principal tributary streams in New York are Chazy, Saranac, and Ausable rivers. A record of the elevation of lake surface at Rouse Point has been kept by United States engineers at Fort Montgomery, beginning with 1875.

In 1896 the construction of the dam and power plant at Chambly was begun for the Royal Electric Company of Montreal.[a] The dam is of concrete masonry, strengthened with embedded bent iron bars. It has an ogee cross section, a vertical upstream face, and a crest 6 feet wide, sloping downward from the lip to the upstream edge 2 inches per foot. The height of the dam from apron to crest is 18 feet, and it affords a fall of 28 feet at the power house. A calibration curve of Richelieu River was calculated by the United States Board of Engineers on Deep Waterways, by comparing the computed discharge over this dam with the corresponding stage of Lake Champlain at Fort Montgomery, taking into consideration the slope of Richelieu River in the intervening distance of 35 miles from Rouse Point to Chambly. From this curve the discharge in second-feet, corresponding to the observed stages of Lake Champlain at Fort Montgomery, has been deduced.[b]

Relation of elevation of Lake Champlain and discharge of Richelieu River.

Elevation of Lake Champlain at Fort Montgomery, N. Y.	Discharge of Richelieu River at Chambly, P. Q.	Elevation of Lake Champlain at Fort Montgomery, N. Y.	Discharge of Richelieu River at Chambly, P. Q.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*
94	5,000	98	19,500
95	8,500	99	24,000
96	12,000	100	29,500
97	15,500	101	36,000

[a] Described in Engineering Record for June 17, 1899, pp. 50-51.

[b] Report of U. S. Board of Engineers on Deep Waterways, Pt. I, pp. 321-328.

Mean monthly run-off of Lake Champlain at Chambly, Province of Quebec. 1875–1901.

[Drainage area, 7,750 square miles.]

MEAN MONTHLY FLOW IN SECOND-FEET.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Discharge for mean stage.
1875	5,800	5,900	8,700	19,200	21,500	15,900	11,700	9,500	8,200	9,300	12,300	11,300	11,400
1876	14,400	13,900	16,100	22,700	30,400	20,700	13,900	9,400	6,600	6,000	5,700	5,000	13,200
1877	4,900	5,200	8,300	19,100	17,200	11,700	10,900	10,100	8,600	8,100	10,900	12,300	10,500
1878	10,400	8,700	12,000	19,300	21,200	13,800	10,100	13,100	12,700	8,600	9,300	17,800	13,000
1879	14,800	12,700	13,800	19,400	27,000	16,600	12,000	8,900	6,800	5,600	6,100	11,000	12,600
1880	11,300	14,000	15,900	17,100	15,800	11,400	8,500	6,300	4,400	3,800	9,100	8,300	10,400
1881	6,900	8,200	13,900	15,500	20,300	14,500	10,100	8,000	6,500	5,400	6,900	8,500	10,300
1882	12,100	11,500	16,800	15,600	14,700	17,200	13,800	9,700	7,600	7,200	5,500	4,400	11,200
1883	4,000	5,000	6,800	17,800	21,800	17,700	13,500	9,700	6,300	4,700	4,700	4,900	9,500
1884	5,300	8,700	14,900	25,300	23,400	16,100	10,300	8,900	5,500	5,000	5,700	8,300	11,000
1885	11,400	11,200	9,900	19,600	24,900	15,300	11,600	9,600	9,700	6,000	16,800	16,700	13,700
1886	17,000	16,000	15,400	22,900	19,200	13,900	10,300	8,100	6,200	6,200	8,400	13,100	12,800
1887	10,700	15,000	13,100	23,600	29,000	19,500	13,400	9,900	7,400	5,300	5,000	9,700	13,000
1888	10,600	10,900	12,900	23,900	30,200	19,700	12,900	9,200	9,900	11,700	15,200	16,200	15,000
1889	19,300	16,200	14,300	20,200	19,600	17,500	15,300	12,900	9,600	11,400	12,000	14,900	15,100
1890	13,900	16,000	18,800	20,800	25,500	26,200	14,000	9,700	14,200	13,800	14,200	13,300	16,200
1891	12,700	16,000	23,400	28,600	23,100	14,200	9,900	8,200	7,300	5,400	5,000	7,200	12,900
1892	13,400	12,700	11,300	20,000	17,300	19,100	23,900	18,700	15,300	10,400	11,000	11,000	15,100
1893	8,400	7,900	9,700	16,200	21,700	15,800	9,800	8,000	11,800	8,500	6,600	6,700	10,800
1894	9,900	10,100	16,200	17,300	14,900	12,800	9,800	6,900	5,300	5,200	6,900	7,100	10,100
1895	7,800	7,400	7,600	17,600	21,300	14,200	9,400	7,600	7,200	5,400	6,700	12,500	10,200
1896	14,800	11,800	18,000	30,500	24,900	14,100	10,300	7,900	6,100	6,500	9,100	9,700	10,100
1897	8,300	7,900	10,600	21,600	24,800	21,900	19,300	18,400	12,300	8,500	9,800	15,400	14,500
1898	14,400	14,900	22,900	24,500	18,600	13,800	9,800	7,400	6,500	8,700	10,300	9,600	13,200
1899	10,630	9,618	13,332	21,678	24,595	13,903	9,622	6,877	5,174	4,531	8,950	11,432	11,700
1900	10,900	14,510	16,046	22,242	18,040	18,786	12,014	9,300	7,178	6,593	8,037	13,327	13,080
1901	11,920	9,888	10,338	30,678	28,433	20,939	13,236	10,057	7,604	6,377	6,082	10,463	13,830
Mean	10,960	11,180	13,740	21,220	22,200	16,560	12,200	9,720	8,290	7,190	8,750	10,750	12,390

RUN-OFF IN SECOND-FEET PER SQUARE MILE.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Run-off for mean stage.
1875	0.75	0.76	1.12	2.48	2.77	2.05	1.51	1.23	1.06	1.20	1.59	1.46	1.47
1876	1.86	1.79	2.08	2.93	3.92	2.67	1.79	1.21	.98	.77	.74	.64	1.70
1877	.63	.67	1.07	2.46	2.22	1.51	1.41	1.30	1.11	1.04	1.41	1.59	1.35
1878	1.34	1.12	1.55	2.49	2.75	1.78	1.30	1.69	1.64	1.11	1.20	2.30	1.68
1879	1.91	1.64	1.78	2.50	3.48	2.14	1.55	1.15	.88	.72	.79	1.42	1.63
1880	1.46	1.81	2.05	2.21	2.04	1.47	1.10	.81	.57	.49	1.17	1.07	1.34
1881	.89	1.06	1.79	2.00	2.62	1.87	1.30	1.03	.84	.70	.89	1.10	1.33
1882	1.56	1.48	2.17	2.01	1.90	2.22	1.78	1.25	.98	.93	.71	.57	1.44
1883	.52	.64	.88	2.30	2.81	2.28	1.74	1.25	.81	.61	.61	.63	1.23
1884	.68	1.12	1.92	3.26	3.02	2.08	1.33	1.15	.71	.64	.74	1.07	1.42
1885	1.47	1.44	1.28	2.53	3.21	1.97	1.50	1.24	1.25	.77	2.17	2.15	1.77
1886	2.19	2.06	1.99	2.95	2.48	1.79	1.33	1.04	.80	.80	1.08	1.69	1.65
1887	1.38	1.93	1.69	3.04	3.74	2.52	1.73	1.28	.95	.68	.64	1.25	1.68
1888	1.37	1.41	1.66	3.08	3.90	2.54	1.66	1.19	1.28	1.51	1.96	2.09	1.93
1889	2.49	2.08	1.84	2.61	2.53	2.26	1.97	1.66	1.24	1.47	1.55	1.92	1.95
1890	1.79	2.06	2.43	2.68	3.29	2.99	1.81	1.25	1.83	1.78	1.83	1.72	2.09
1891	1.64	2.06	3.04	3.69	2.98	1.83	1.28	1.06	.94	.70	.70	.64	1.66
1892	1.73	1.64	1.46	2.58	2.23	2.46	3.08	2.41	1.97	1.34	1.34	1.42	1.95
1893	1.08	1.02	1.25	2.09	2.80	2.04	1.26	1.03	1.52	1.10	.85	.86	1.35
1894	1.28	1.30	2.09	2.23	1.92	1.65	1.26	.89	.68	.67	.89	.92	1.30
1895	1.01	.95	.98	2.27	2.75	1.83	1.21	.98	.93	.70	.86	1.61	1.32
1896	1.91	1.52	2.32	3.93	3.21	1.82	1.33	1.02	.79	.84	1.17	1.25	1.30
1897	1.07	1.02	1.37	2.79	3.20	2.83	2.49	2.37	1.59	1.10	1.26	1.99	1.87
1898	1.86	1.92	2.95	3.16	2.40	1.78	1.26	.95	.84	1.12	1.33	1.24	1.70
1899	1.37	1.24	1.72	2.80	3.17	1.79	1.24	.89	.67	.58	1.15	1.48	1.51
1900	1.41	1.87	2.07	2.87	2.33	2.42	1.55	1.20	.93	.85	1.04	1.72	1.69
1901	1.54	1.28	1.33	3.96	3.67	2.70	1.71	1.30	.98	.82	.78	1.35	1.78
Mean	1.41	1.44	1.77	2.74	2.86	2.12	1.57	1.25	1.03	.93	1.13	1.38	1.60

Mean monthly run-off of Lake Champlain at Chambly, Province of Quebec, 1875–1901—Continued.

RUN-OFF IN INCHES ON DRAINAGE AREA.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1875	0.86	0.79	1.29	2.78	3.19	2.30	1.74	1.41	1.19	1.29	1.78	1.68
1876	2.14	1.93	2.39	3.28	4.51	2.99	2.06	1.39	1.10	.89	.83	.74
1877	.72	.70	1.23	2.76	2.55	1.69	1.62	1.49	1.24	1.20	1.58	1.83
1878	1.54	1.16	1.78	2.79	3.14	1.99	1.49	1.94	1.84	1.28	1.34	2.64
1879	2.20	1.71	2.05	2.80	4.00	2.40	1.78	1.32	.99	.83	.88	1.63
1880	1.68	1.95	2.36	2.48	2.35	1.65	1.26	.93	.64	.56	1.31	1.23
1881	1.02	1.10	2.06	2.24	3.01	2.09	1.49	1.18	.94	.81	1.00	1.26
1882	1.79	1.54	2.50	2.25	2.19	2.49	2.05	1.44	1.10	1.07	.80	.66
1883	.60	.67	1.01	2.58	3.23	2.55	2.00	1.44	.91	.70	.68	.72
1884	.78	1.21	2.21	3.65	3.47	2.33	1.53	1.32	.80	.74	.83	1.23
1885	1.69	1.50	1.47	2.83	3.69	2.21	1.72	1.43	1.40	.89	2.43	2.47
1886	2.52	2.14	2.29	3.30	2.85	2.00	1.53	1.20	.90	.92	1.21	1.94
1887	1.59	2.01	1.94	3.40	4.30	2.82	1.99	1.47	1.06	.78	.72	1.44
1888	1.58	1.52	1.91	3.45	4.49	2.84	1.91	1.37	1.43	1.74	2.20	2.40
1889	2.86	2.16	2.12	2.92	2.91	2.53	2.27	1.91	1.39	1.69	1.74	2.21
1890	2.06	2.14	2.79	3.00	3.78	3.35	2.08	1.44	2.05	2.05	2.05	1.98
1891	1.89	2.14	3.50	4.13	3.43	2.05	1.47	1.22	1.05	.81	.78	.74
1892	1.99	1.77	1.68	2.89	2.56	2.76	3.54	2.77	2.21	1.54	1.50	1.63
1893	1.24	1.06	1.44	2.34	3.22	2.28	1.44	1.18	1.70	1.26	.95	.99
1894	1.47	1.35	2.39	2.50	2.21	1.85	1.44	1.02	.76	.77	1.00	1.06
1895	1.16	.99	1.13	2.54	3.16	2.05	1.39	1.13	1.04	.81	.96	1.85
1896	2.20	1.64	2.67	4.40	3.69	2.04	1.57	1.17	.88	.97	1.31	1.44
1897	1.23	1.06	1.58	3.12	3.68	3.17	2.86	2.73	1.78	1.26	1.41	2.29
1898	2.14	2.00	3.39	3.54	2.76	1.99	1.45	1.09	.94	1.29	1.49	1.43
1899	1.58	1.29	1.98	3.12	3.66	2.90	1.43	1.03	.75	.67	1.28	1.71
1900	1.63	2.60	2.39	3.20	2.69	2.70	1.79	1.38	1.04	.98	1.16	1.98
1901	1.78	1.33	1.53	4.42	4.24	3.01	1.97	1.50	1.09	.95	.87	1.56
Mean	1.63	1.53	2.04	3.06	3.29	2.38	1.81	1.44	1.19	1.07	1.26	1.58

Mean daily discharge, in second-feet, of Richelieu River at Chambly, Province of Quebec.

[Drainage area, 7,750 square miles.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1899.												
1		10,100	9,760	13,980	30,530	17,610	10,440	8,400	5,680	4,490	5,340	9,080
2		10,100	10,100	13,980	31,150	17,120	10,270	8,740	5,850	4,660	6,020	8,740
3		10,100	10,270	13,600	30,840	16,830	10,100	8,230	.....	4,830	7,720	.....
4		10,100	10,950	13,600	30,840	16,640	.....	8,060	5,680	5,340	8,910	9,080
5		.....	.....	13,600	30,840	16,450	10,100	7,890	6,870	4,490	.....	9,250
6		.....	9,930	11,120	13,790	30,530	16,260	9,080	.....	4,490	5,000	8,910	9,180
7		.....	9,760	11,460	13,980	29,600	15,880	9,760	7,380	5,170	4,660	9,250	9,420
8		.....	9,420	12,340	14,740	28,730	15,560	9,760	7,040	4,830	.....	9,420	8,570
9		.....	9,420	12,520	.....	27,860	15,120	.....	7,210	4,660	5,000	9,590	8,740
10		.....	9,250	12,880	16,830	27,570	14,740	10,270	7,210	.....	4,830	9,420	.....
11		.....	9,080	13,240	17,610	28,440	.....	10,270	7,550	6,190	5,170	9,250	9,080
12		.....	.....	.....	17,400	26,180	15,120	10,440	7,720	6,020	4,660	.....	10,100
13		.....	9,250	13,600	18,450	26,440	14,740	10,270	.....	4,320	4,490	9,420	10,270
14		.....	9,080	13,600	19,080	24,620	13,790	9,930	6,700	4,150	4,440	9,350	10,780
15		.....	9,420	14,360	20,380	24,100	13,980	9,250	6,700	3,980	.....	10,270	11,630
16	10,440	.....	9,420	13,980	21,480	25,860	13,060	.....	6,870	4,660	4,490	8,910	11,800
17	10,780	.....	9,420	14,360	22,660	25,380	13,060	9,750	6,700	.....	5,680	9,250	.....
18	10,610	.....	9,420	14,740	25,380	25,860	.....	9,420	6,700	4,320	3,980	10,610	12,160
19	10,780	.....	9,250	.....	25,860	22,420	12,880	9,250	6,530	3,470	4,320	.....	11,800
20	10,780	.....	9,250	14,740	25,140	21,700	13,060	9,420	.....	3,640	3,980	9,080	12,260
21	10,610	.....	9,250	15,120	25,660	20,820	11,800	9,930	6,360	3,980	3,810	9,080	13,240
22		.....	10,100	14,740	26,700	20,950	11,800	9,250	6,700	4,660	3,640	9,420	12,880
23	10,610	.....	9,420	14,740	27,280	20,600	12,880	.....	6,530	5,860	4,490	9,080	13,790
24	11,290	.....	9,590	14,740	28,150	20,160	12,160	9,420	6,700	6,700	4,320	9,080	.....
25	10,440	.....	9,760	14,740	28,730	19,940	.....	9,590	6,530	5,680	4,320	9,080	13,420
26	11,120	.....	.....	.....	29,310	19,720	11,630	9,250	6,530	4,830	4,150	.....	12,880
27	10,270	.....	10,100	14,550	29,724	17,400	11,460	8,740	.....	5,170	3,810	9,160	12,880
28	10,610	.....	10,270	14,360	30,530	18,660	10,780	8,910	6,020	5,680	4,320	9,250	12,700
29	10,440	.....	.....	14,170	30,530	19,500	10,610	8,910	4,285	6,020	.....	8,570	12,340
30	10,440	.....	.....	14,360	30,530	17,400	10,440	.....	4,320	5,170	4,490	9,080	12,160
31	10,270	.....	.....	14,170	.....	17,820	.....	8,400	6,190	.....	5,000	.....	.....
Mean	10,630	9,618	13,322	21,678	24,595	13,903	9,622	6,877	5,174	4,531	8,942	11,432

Mean daily discharge, in second-feet, of Richelieu River at Chambly, Province of Quebec—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1900.												
1	11,800	11,120	17,400	19,690	34,350	21,480	13,600	9,930	8,060	6,360	7,210	13,240
2	11,800	11,120	17,310	15,880	35,670	22,420	13,420	9,930	8,740	6,530	6,530	13,240
3	11,630	11,460	17,120	16,260	33,690	.....	14,170	9,420	9,080	6,870	6,190	13,420
4	11,800	11,120	.....	17,120	32,700	22,420	13,240	9,250	8,230	6,700	6,700	13,240
5	11,630	10,950	17,120	18,240	38,450	22,660	12,880	.....	8,230	6,700	6,190	13,600
6	10,950	11,120	17,310	18,240	.....	22,660	13,060	9,080	7,720	6,360	6,020	14,170
7	.....	11,460	17,120	19,080	36,700	22,420	12,880	9,420	7,380	8,400	6,870	14,930
8	10,440	11,460	17,120	.....	36,350	21,940	.....	9,760	7,720	6,530	6,020	14,360
9	10,780	11,460	16,830	20,820	36,000	20,820	12,520	9,250	.....	6,360	5,680	13,980
10	10,950	11,800	13,980	21,260	35,670	20,380	12,520	9,760	7,040	6,360	6,190	14,360
11	10,270	11,980	16,260	21,480	28,730	.....	12,700	9,250	7,550	6,190	6,530	14,360
12	10,440	12,160	16,070	21,700	28,730	19,720	12,340	9,080	7,890	6,530	7,040	14,170
13	10,270	12,520	16,270	21,700	.....	20,160	12,160	9,420	6,870	6,530	6,700	15,120
14	.....	15,310	15,880	22,420	27,860	20,600	11,800	9,590	6,700	6,530	7,040	13,790
15	10,100	16,260	15,880	.....	26,700	18,660	.....	9,930	6,700	6,530	7,210	13,790
16	9,930	17,310	15,790	22,900	26,700	18,450	11,980	9,930	.....	7,210	6,870	13,600
17	9,760	17,610	15,880	25,380	26,700	.....	11,290	9,250	6,700	6,530	7,550	13,600
18	10,440	.....	16,180	24,880	26,180	17,820	11,460	9,760	5,850	6,530	7,890	13,540
19	9,930	18,030	15,690	26,440	25,920	17,400	11,120	.....	6,360	6,190	7,040	13,240
20	10,270	17,820	15,500	29,600	.....	17,120	11,460	9,420	7,380	6,530	7,550	13,240
21	10,100	17,730	15,420	31,770	26,440	17,120	12,340	9,250	7,040	6,700	9,250	13,240
22	11,120	17,400	15,690	33,360	26,180	16,830	.....	9,420	6,700	6,530	9,420	13,060
23	11,220	17,530	15,310	34,680	25,920	16,450	11,050	9,250	.....	6,360	10,270	13,600
24	10,610	17,820	15,880	35,670	25,400	.....	10,780	9,590	6,360	6,530	10,730	12,700
25	11,800	17,400	15,690	36,350	25,140	15,880	10,610	9,080	6,530	6,360	11,290	13,420
26	11,200	17,400	15,500	36,700	24,880	16,070	10,440	8,910	6,700	7,040	11,460	13,420
27	11,290	17,310	15,500	36,700	.....	15,310	10,610	8,740	6,360	6,530	11,980	.....
28	.....	17,120	15,500	36,350	25,620	14,550	10,440	8,570	6,190	6,700	12,520	.....
29	11,460	.....	15,500	.....	25,140	14,550	.....	8,740	7,040	6,530	13,240	.....
30	11,630	.....	15,310	35,670	22,900	14,550	10,270	8,400	6,700	5,850	12,880	13,420
31	11,460	.....	15,310	.....	22,420	.....	11,120	8,230	.....	6,870	.....	13,240
Mean	10,900	14,510	16,046	22,242	18,040	18,786	12,014	9,300	7,178	6,593	8,037	13,327
1901.												
1	12,700	10,780	9,080	18,240	35,340	25,620	16,830	10,780	8,570	6,700	6,190	6,360
2	13,060	10,780	8,910	18,660	37,050	25,380	17,120	10,780	8,500	7,720	5,680	6,530
3	12,700	10,610	.....	18,870	33,030	25,380	15,880	10,950	8,740	6,360	6,020	6,020
4	12,880	10,440	9,080	19,290	33,690	25,140	15,690	10,480	8,740	6,020	6,700	6,020
5	12,700	10,610	8,740	20,380	32,700	25,140	14,550	10,100	8,910	6,020	5,680	6,020
6	12,700	10,270	8,570	21,700	32,700	22,900	15,600	10,100	8,740	5,170	5,510	6,190
7	12,700	10,440	8,740	25,620	32,590	22,420	15,120	10,440	8,400	6,020	5,680	6,360
8	12,340	10,270	8,570	26,180	31,460	22,660	14,360	10,950	8,060	6,360	5,680	6,360
9	12,160	10,100	8,500	29,600	30,530	21,940	14,550	10,100	7,890	6,190	5,850	6,530
10	11,980	10,100	8,400	31,460	29,910	21,940	14,360	11,460	8,060	6,020	4,830	6,530
11	11,800	10,100	8,570	31,770	29,310	22,180	13,790	10,440	7,720	5,680	5,680	6,700
12	12,160	10,000	8,740	32,700	28,540	21,700	13,600	10,270	7,720	6,360	6,020	7,210
13	11,980	9,930	8,570	32,700	28,730	21,260	13,420	10,270	7,720	6,700	4,660	8,060
14	11,980	9,930	8,740	33,030	28,440	21,260	13,600	10,780	7,720	5,850	5,680	8,400
15	11,800	9,760	8,740	33,360	27,860	20,820	13,240	10,950	8,400	6,360	5,850	9,590
16	12,340	9,930	8,570	34,020	26,700	20,380	13,600	10,100	8,060	6,700	6,020	11,800
17	11,630	9,760	8,740	34,020	26,180	19,720	13,240	10,100	7,550	6,360	6,020	13,420
18	11,460	9,690	8,910	35,670	25,920	19,500	12,880	9,930	7,380	6,190	5,850	13,980
19	11,460	9,590	8,740	34,550	25,660	19,290	12,340	9,930	7,380	8,060	5,680	14,170
20	11,800	9,420	8,740	34,020	26,180	19,080	12,160	9,760	7,380	6,190	5,850	14,360
21	12,700	9,420	9,080	35,340	26,180	19,290	12,520	9,590	7,210	6,190	6,020	13,980
22	11,460	9,420	9,760	35,340	26,180	19,080	11,800	10,100	8,060	6,190	6,360	14,740
23	11,460	9,420	10,270	36,000	26,180	18,660	11,630	10,440	7,380	6,360	5,680	14,360
24	11,460	9,690	11,120	36,700	25,400	18,550	11,460	9,590	6,190	6,700	6,020	14,360
25	11,290	9,590	11,290	36,700	25,400	18,450	11,290	9,080	6,020	5,850	5,510	13,980
26	11,120	9,490	12,340	37,050	25,140	18,450	11,120	9,080	6,360	7,720	5,170	13,980
27	11,120	8,250	13,790	37,050	24,720	18,240	10,780	9,080	6,360	5,850	5,340	13,790
28	11,220	9,080	15,880	36,700	24,620	18,030	11,120	8,910	6,700	6,020	5,510	13,790
29	11,290	.....	16,450	36,000	24,100	17,610	10,780	9,080	6,190	6,360	6,020	13,980
30	11,120	.....	17,120	35,670	25,860	17,400	10,780	9,420	6,020	6,700	5,680	13,980
31	10,950	.....	17,400	.....	25,140	.....	11,120	8,740	.....	6,700	.....	13,790
Mean	11,920	9,888	10,338	30,613	28,433	20,939	13,236	10,057	7,604	6,377	6,082	10,463

Mean monthly run-off of Lake Champlain drainage basin at Chambly, Province of Quebec.

[Drainage area, 7,750 square miles.]

MEAN MONTHLY FLOW IN SECOND-FEET.

	1899.	1900.	1901.
January	10,630	10,900	11,920
February	9,618	14,510	9,888
March	13,322	16,046	10,338
April	21,678	22,242	30,618
May	24,595	18,040	28,433
June	13,903	18,786	20,939
July	9,622	12,014	13,236
August	6,877	9,300	10,057
September	5,174	7,178	7,604
October	4,531	6,593	6,377
November	8,950	8,037	6,082
December	11,432	13,327	10,463

RUN-OFF IN SECOND-FEET PER SQUARE MILE.

January	1.37	1.41	1.53
February	1.25	1.87	1.28
March	1.63	2.06	1.33
April	2.80	2.86	3.95
May	3.17	2.32	3.66
June	1.79	2.42	2.70
July	1.25	1.54	1.32
August	.89	1.20	1.70
September	.67	.92	.98
October	.58	.85	.82
November	1.15	1.04	.78
December	1.47	1.72	1.35

RUN-OFF IN INCHES ON DRAINAGE AREA.

January	1.58	1.62	1.76
February	1.30	1.94	1.33
March	1.87	2.37	1.53
April	3.14	3.20	4.42
May	3.65	2.67	4.21
June	2.00	2.72	3.02
July	1.44	1.77	1.52
August	1.02	1.38	1.96
September	.75	1.03	1.10
October	.67	.98	.94
November	1.29	1.16	.87
December	1.69	1.98	1.55

UPPER HUDSON RIVER DRAINAGE.

INDIAN RIVER AT INDIAN LAKE DAM, HAMILTON COUNTY, N. Y.

Indian River, a tributary of the Upper Hudson, contains a precipitous forested mountain area of 146 square miles in eastern Hamilton County. In 1898 a masonry storage dam was built at the foot of Indian Lake, replacing the lumberman's dam which was formerly

there and raising the level of the artificial lake so formed 23 feet. The storage capacity of the present lake is 5,000,000,000 cubic feet. The area of the water surface of the lake is 5,035 acres, and the elevation of the spillway crest above mean tide is 1,650 feet. The dam was built by a federation of water-power users on the Hudson River in cooperation with the State of New York, the primary object being to store flood water from this drainage area to be turned into the Hudson during the low-water period of each year, thereby equalizing the flow to some extent. Water is also used for sluicing logs during the river-driving season.[a]

Since July 22, 1900, a gaging record has been kept at the dam with a view to determining the total outgo from this reservoir, the facts recorded being the elevation of the water surface in the reservoir, depth of water flowing over the spillway or flashboards, width of opening and head on the main and subsidiary log ways, and the width of opening of each of the 5-foot sluice gates, together with the effective head on the openings. These facts will enable a calculation of the outflow from the reservoir to be made, and, by comparison with gaging records kept on Hudson River at Fort Edward and Mechanicville, the effect of storage on the low-water flow of the Hudson can be determined.

A meteorological station has been established at the dam by the United States Weather Bureau, including rainfall, temperature, and other records. The regimen of flow of Indian River below the dam is largely artificial, though in the course of a year or more the total annual run-off of the drainage area will appear in the stream, and it is hoped in the course of time to determine the relation between the rainfall and run-off of what constitutes rather a typical Adirondack watershed.

When the reservoir is full the excess of inflow passes over the spillway, which has a level crest 106.05 feet long in the clear. To facilitate the calculation of discharge over this spillway, a series of experiments were made at Cornell University June 6, 1899, on a full-sized model of the spillway section 6.58 feet long, from which the proper coefficients of discharge have been determined.[b]

The discharge through the two 5-foot sluice gates, provided as a means for drawing the water down as required, is calculated from the observed head and from the area of the lune-shaped gate orifices by the ordinary formula. The value of the coefficients of discharge to be applied may be checked by current-meter measurements made at a convenient bridge below the dam. The results of these calculations will be somewhat uncertain until the reservoir is cleared of drift, which tends to obstruct the gate openings during low water.

A measurement of the flow at this point on October 19, 1900, showed

---

[a] See Engineering News, May 18, 1899.

[b] Trans. Am. Soc. Civil Eng., Vol. XLIV, p. 283.

the rate of draft from the reservoir to be 541 second-feet, both sluice gates being full opened under an effective head of 6.25 feet. Until additional measurements can be made under favorable conditions, the flow through the sluice gates will be calculated by means of the formula for orifices, using the ordinary coefficient 0.62.

A measurement of the Hudson River at Mechanicville, made on the afternoon of the following day, October 20, 1900, showed the total flow at that point to be 1,871 second-feet.

The following tables show the stage of and draft from Indian Lake reservoir during the present year, the depth being measured with reference to the base of the invert of the 5-foot discharge tunnels as a datum.

Stage of water in Indian Lake reservoir for 1900.

Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1		29.42	25.01	16.00	8.62		17		27.00	20.50	11.83	6.33	
2		29.17	25.00	15.75	8.37	9.50	18		27.00	20.08	11.54	6.17	10.83
3		28.92	24.83	15.46	8.17		19		27.00	19.75	11.25	6.08	
4		28.75	24.58	15.17	8.00		20		27.00	19.42	11.00	6.33	
5		28.58	24.33	14.87	7.79		21		27.00	19.17	10.79	6.50	
6		28.33	24.17	14.58	7.58		22	33.50	27.00	18.87	10.54	6.58	11.08
7		28.25	23.92	14.42	7.42		23	33.00	26.92	18.54	10.33	6.58	
8		28.08	23.58	14.08	7.33		24	32.50	26.75	18.25	10.12		11.25
9		27.92	23.29	13.79	7.33	10.25	25	32.17	26.63	17.92	9.96		
10		27.83	22.00	13.50	7.29		26	31.92	26.37	17.58	9.79		11.58
11		27.67	22.71	13.21	7.25		27	31.25	26.17	17.25	9.58		
12		27.33	22.37	12.92	7.17	10.42	28	30.83	26.00	16.92	9.38		
13		27.29	21.00	12.67	7.00		29	30.42	25.83	16.67	9.17		11.83
14		27.25	21.63	12.42	6.87		30	30.08	25.58	16.33	8.96	9.25	
15		27.21	21.25	12.25	6.71		31	29.75	25.33		8.83		12.08
16		27.12	20.88	12.08	6.50	10.75							

Stage of water in Indian Lake reservoir for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	12.17	9.63	2.92	8.58	30.42	35.75	35.25	32.25	31.08	25.92	23.25	17.00
2	12.25	9.42		8.92	30.83	35.75	35.21	32.17	30.92	25.92	22.92	16.83
3		9.25	2.42	9.25	31.17	35.75	35.17	32.08	30.75	25.87	22.58	16.50
4				9.50	31.42	35.67	35.17	32.00	30.58	25.58	22.25	16.17
5	12.33	8.83		9.83	31.67	35.50	35.17	32.04	30.42	25.17	21.92	16.87
6			1.83	10.08	31.92	35.33	35.17	32.08	30.25	24.75	21.58	15.58
7				10.50	32.00	35.33	35.17	32.08	30.08	24.33	21.25	15.29
8	12.50	8.08		11.00	32.08	35.33	35.17	32.08	29.87	24.00	20.92	15.00
9	12.58			11.50	32.17	35.25	35.17	32.17	29.58	23.67	20.58	14.71
10		7.75	1.33	11.92	32.25	35.17	35.17	32.33	29.33	23.33	20.25	14.58
11			1.17	12.25	32.50	35.08	35.17	32.42	29.08	23.00	19.92	14.50
12			2.92	12.67	32.75	35.00	35.17	32.50	28.75	22.75	19.67	14.54
13	12.08	7.17	3.08	13.17	33.08	34.92	35.21	32.58	28.50	22.50	19.42	14.71
14			3.25	13.67	33.25	34.83	35.25	32.67	28.25	22.50	19.33	14.92
15				14.50	33.33	34.75	35.25	32.67	28.00	22.58	19.42	16.50
16	11.83	6.42		15.17	33.42	34.67	35.25	32.71	27.87	22.75	19.50	17.50
17			3.75	16.00	33.50	34.58	35.33	32.79	27.92	22.92	19.54	18.08
18				17.00	33.75	34.67	35.08	32.83	28.00	23.00	19.58	18.42
19	11.50	5.67		17.83	33.92	34.75	34.83	32.87	28.04	23.08	19.63	18.75
20			4.00	18.50	34.17	34.83	34.58	32.87	28.08	23.25	19.67	18.87
21	11.33		4.25	19.67	34.33	34.92	34.33	33.00	28.12	23.33	19.71	19.02
22		4.92	4.50	22.00	34.50	35.08	34.00	32.75	28.17	23.42	19.75	19.15
23			4.75	24.17	34.75	35.25	33.75	32.58	28.17	23.58	19.58	19.23
24	11.00		5.00	25.25	34.92	35.25	33.50	32.58	28.00	23.67	19.25	19.30
25		4.17	5.25	26.33	35.08	35.25	33.25	32.33	27.67	23.71	18.92	19.42
26			5.58	27.17	35.25	35.25	33.08	32.17	27.25	23.75	18.58	19.50
27	10.50		6.33	28.00	35.33	35.25	32.92	32.00	26.87	23.79	18.25	19.58
28		3.42	6.83	28.58	35.42	35.25	32.75	31.87	26.50	23.83	18.00	19.71
29	10.17		7.42	29.17	35.50	35.25	32.50	31.58	26.00	23.92	17.67	19.83
30			7.83	29.75	35.67	35.25	32.33	31.42	25.75	23.92	17.33	19.92
31	9.83		8.17		35.75		32.33	31.25		23.58		20.00

The estimated storage capacity of the reservoir is as follows:

Estimated storage capacity of Indian Lake reservoir.

	Elevation.	Area.	Storage.
		Acres.	*Cubic feet.*
Original lake	1,616.17	1,000	
Lumberman's dam	1,627	3,007	800,000,000
Crest present dam	1,650	5,035	4,468,000,000
Top flashboards present dam	1,651.1		5,000,000,000

SCHROON RIVER AT WARRENSBURG, WARREN COUNTY, N. Y.

A gaging record was established at the dam of the Schroon River Pulp Company, 2 miles below Warrensburg, November 1, 1895, in connection with Upper Hudson storage survey.[a] Conditions at the Warrensburg gaging station are somewhat peculiar. During ordinary water an attempt is made to turn the entire flow of the stream, less leakage, through the water wheels, which run twenty-four hours per day, Sundays excepted. This is accomplished by the use of flashboards and by draft from the storage impounded by Starbuckville dam. During extreme low water the mill is shut down altogether. As a rule, no water passes over the dam at this time, the entire flow leaking through. A balance is maintained between the inflow and outgo by fluctuations in the pond level, thereby varying the pond storage and also the head on the leaks. As no record is kept when the mill is not running, it has been necessary to estimate the low-water flow, which was taken at 150 second-feet in 1899, this being the assumed leakage of the Starbuckville dam.[b]

The apparently uniform regimen of the stream during considerable periods of time may partly be accounted for as the result of draft and storage from the Starbuckville dam.

A current-meter measurement of the leakage of the dam, flume, and flashboards at the Schroon River Pulp Company's mill was made on August 9, 1900, in the open channel about one-half mile below the dam. The flow at this point was found to be 285 second-feet. This amount has been taken as the low-water flow and leakage during 1900 and 1901. The dam is of timber, and was considered nearly watertight when built. There is evidence that the leakage has increased year by year.

The flow over the dam, without flashboards, has been taken from a diagram which was deduced from experiments made at Cornell University on a weir having a similar cross section. The flow over flashboards has been calculated by means of the Francis formula.

[a] See Report of State Engineer and Surveyor of New York, 1895, p. 148; also Water-Supply and Irrigation Paper No. 35, p. 58.

[b] See Report of the Merchants' Association of New York on the Water Supply of the City of New York, p. 337.

During 1901 the station has been equipped with new standard board gages. Readings are taken once each day and the record is furnished by Mr. Frank Goodfellow:

High-water discharge of Schroon River at Warrensburg.

Date.	Year.	Maximum discharge.	Maximum discharge per square mile.
		Second-feet.	*Second-feet.*
December 30–31	1895	4,074	7.21
April 20	1896	7,109	12.58
April 19	1897	3,982	7.05
March 14–19	1898	4,044	7.16
April 24–30	1899	5,103	9.03
April 22	1900	7,745	13.71
April 16	1901	6,802	31.19

Mean daily flow, in second-feet, of Schroon River below Warrensburg, Warren County, N. Y., for 1901.

[Drainage area, 562 square miles.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	768	612	535	1,702	2,952	2,282	671	415	[a] 535	729	667	([a])
2	768	612	535	1,992	2,752	([a])	671	415	555	729	667	430
3	768	.....	.....	2,452	2,622	2,292	671	415	575	729	([a])	413
4	768	612	535	3,152	2,152	2,292	633	[a] 415	595	729	612	430
5	768	612	535	3,732	([a])	1,932	633	415	635	729	684	430
6	.....	612	535	4,132	1,992	1,932	633	425	635	[a] 594	684	430
7	834	612	535	([a])	1,932	1,932	([a])	425	675	594	684	389
8	834	612	535	4,552	1,872	1,792	729	425	[a] 675	594	684	([a])
9	834	612	535	5,087	1,812	([a])	729	445	675	.....	684	353
10	834	.....	.....	5,222	1,742	1,792	729	445	675	729	([a])	353
11	834	535	535	5,302	1,742	1,762	729	[a] 445	695	729	.....	566
12	834	535	535	5,652	([a])	1,742	729	475	695	729	592	566
13	.....	535	535	5,967	1,512	1,742	729	475	695	([a])	592	566
14	834	535	535	([a])	1,552	1,662	([a])	475	695	594	592	566
15	834	535	535	6,302	1,782	1,592	.....	475	[a] 715	6,2	592	([a])
16	834	535	535	6,882	2,092	([a])	729	495	715	806	592	939
17	834	.....	.....	6,797	2,472	1,532	729	515	715	806	([a])	806
18	834	535	535	6,302	2,472	1,462	729	[a] 515	715	806	592	806
19	834	535	535	5,967	([a])	1,412	729	515	715	806	592	939
20	.....	535	535	5,602	2,282	1,342	729	515	715	([a])	592	939
21	768	535	535	([a])	2,472	1,282	([a])	515	715	351	592	939
22	768	535	614	5,087	2,472	1,232	594	535	[a] 715	678	535	([a])
23	768	535	614	5,222	2,472	([a])	501	535	497	678	535	939
24	768	.....	.....	5,372	2,432	939	430	535	594	678	([a])	939
25	768	535	614	5,087	2,432	939	430	[a] 535	594	678	477	.....
26	768	535	939	4,967	([a])	939	430	535	594	678	477	1,027
27	.....	535	1,004	4,502	2,472	939	430	535	594	([a])	477	1,072
28	612	535	1,207	([a])	2,472	949	([a])	535	594	678	477	1,072
29	612	.....	1,207	4,052	2,472	939	430	535	([a])	678	477	([a])
30	612	.....	1,207	3,250	2,472	[a] 939	430	535	.....	678	477	1,006
31	612	.....	.....	.....	2,432	.....	430	535	.....	678	.....	939
Mean	774	561	658	4,786	2,235	1,522	617	481	650	685	588	714

[a] Sunday.

Mean monthly run-off of Schroon River at Warrensburg, Warren County, N. Y.

[Drainage area, 562.5 square miles.]

MEAN MONTHLY FLOW IN SECOND-FEET.

Month.	1895.	1896.	1897.	1898.	1899.	1900.	1901.
January		2,779	337	852	606	810	774
February		516	188	416	478	1,380	561
March		1,664	738	3,194	564	1,140	658
April		3,280	3,164	2,853	2,877	3,688	4,786
May		728	1,822	2,203	3,150	1,688	2,235
June		827	2,384	568	1,093	1,280	1,522
July		276	1,426	216	210	528	617
August		265	1,377	223	150	474	481
September		215	281	166	234	285	650
October		330	166	263	462	488	685
November	478	1,089	2,077	464	1,047	530	588
December	1,233	243	2,776	783	948	773	714
Year		1,018	1,395	1,017	985	1,089	1,189

RUN-OFF IN SECOND-FEET PER SQUARE MILE.

January		4.92	0.60	1.16	1.25	1.44	1.38
February		.92	.33	.74	.85	2.45	1.00
March		2.96	1.31	5.68	1.00	2.02	1.17
April		5.83	5.80	5.07	5.11	6.55	8.48
May		1.11	3.24	3.91	5.60	3.00	3.96
June		1.47	4.24	1.01	1.94	2.27	2.69
July		.49	2.54	.38	.37	.94	1.09
August		.47	2.45	.40	.27	.84	.85
September		.38	.50	.30	.41	.50	1.15
October		.59	.29	.47	.82	.86	1.21
November	0.85	1.94	3.69	.82	1.86	.94	1.05
December	2.19	.43	4.93	1.40	1.68	1.37	1.27
Year		1.79	2.49	1.78	1.76	1.93	2.11

RUN-OFF IN INCHES ON DRAINAGE AREA.

January		5.70	0.69	1.75	1.25	1.66	1.59
February		.95	.35	.77	.89	2.54	1.04
March		3.41	1.51	6.55	1.16	2.32	1.35
April		6.51	6.28	5.66	5.72	7.31	9.50
May		1.49	3.73	4.52	6.47	3.46	4.55
June		1.64	4.73	1.13	2.17	2.53	3.01
July		.56	2.92	.44	.43	1.05	1.24
August		.54	2.82	.46	.31	.47	.98
September		.43	.56	.33	.46	.36	1.29
October		.68	.33	.54	.95	.99	1.39
November	0.94	2.16	4.12	.92	2.08	1.05	1.18
December	2.53	.48	5.69	1.61	1.93	1.58	1.46
Year		24.55	33.73	24.68	23.82	25.32	28.58

HUDSON RIVER AT FORT EDWARD, WASHINGTON COUNTY, N. Y.

This station, which is located at the dam of the International Paper Company, was established in 1895, in connection with Upper Hudson storage surveys.[a] The dam is of framed timber on slate rock foundation, and has but little leakage. The crest is straight, very nearly level, and 587.6 feet in length. The crest gage zero stands at the level of the lip of the dam proper. Flashboards are usually maintained on the dam from 15 inches to 18 inches in height. A record is kept of the height of flashboards, and of the times of their setting and removal.

During 1901 the station has been equipped with new metallic gages of standard form. The crest gage is attached vertically to the timber bulkhead above the left-hand end of the dam. The gages are divided to feet and inches, and readings are taken each morning by Frank Chapman.

There are 62 water wheels in the adjoining mill. These are nearly all of modern types which have been tested at the Holyoke flume. A record is kept of the daily run of each in hours, as well as of the working head, which is usually 19 feet. The discharge through the turbines is taken from diagrams expressing the flow as a function of the working head and number of wheel hours run.

In the winter of 1896–97 a flood spillway was cut around the south end of the dam, over which the water begins to flow whenever it reaches the level of the crest of the flashboards. The profile of the spillway is very irregular and causes some uncertainty in the calculated flows during times of high water.

Whenever the flashboards are off from the main dam the flow is computed by means of the formula used by the East Indian engineers in their computations for irrigation works.[b]

With the flashboards on the flow has been computed from Francis's well-known formula for the sharp-edged weir. During the dry season but little water passes over the dam, the entire flow being employed to drive the turbines. A current-meter measurement was made at the highway bridge below the dam on July 26, 1900. The flow was found to be 2,704 second-feet.

The calculated discharge from the gage readings at the dam and mill varied from 2,420 to 2,720 second-feet while the measurement was being taken. The turbines did not run continuously for twenty-four hours at this rate, however. The mean flow for the day was 1,467 second-feet.

During the navigation season water is diverted from Hudson River at Glens Falls feeder dam, 7 miles above Fort Edward, for the supply of Champlain Canal.

The drainage area tributary to the Hudson above Fort Edward is

[a] See report of State engineer and surveyor of New York, 1895, p. 105. [b] See p. 96.

0.56 of that of the same stream above Mechanicville gaging station. The principal intervening tributaries are the Hoosic River and Batten Kill, having drainage areas of 730 and 460 square miles, respectively.[a]

Mean monthly flow, in second-feet, of the Hudson River at Fort Edward, N. Y., for 1901.

[Drainage area, 2,800 square miles.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2,598	1,698	1,833	11,946	13,265	8,259	3,210	4,216	[a]3,155	2,526	2,504	[a]1,260
2	2,353	1,753	1,833	10,357	12,666	[a]5,368	3,090	1,859	3,474	2,391	1,331	2,244
3	1,818	[a]1,140	[a]485	10,566	11,183	10,135	1,882	1,502	4,889	1,996	[a]2,231	2,336
4	1,638	1,863	1,558	11,633	10,317	8,672	2,231	[a]1,020	4,238	2,391	2,806	2,336
5	1,818	1,863	1,018	12,583	[a]6,925	8,571	2,390	2,190	3,462	1,512	2,769	2,244
6	[a]725	1,808	1,356	13,997	9,585	7,641	1,052	2,911	3,036	[a]1,739	2,909	1,769
7	1,983	1,698	1,183	[a]19,497	7,019	9,913	[a]1,680	2,131	1,498	2,771	2,643	883
8	1,843	1,698	1,193	21,612	7,636	10,266	2,065	3,176	[a]2,231	2,916	2,504	[a]2,131
9	1,958	1,698	1,193	20,196	7,783	[a]9,245	2,290	4,314	2,433	2,771	1,338	1,810
10	1,958	[a]1,055	[a]880	19,658	7,331	10,831	2,030	2,452	2,136	2,651	[a]1,950	2,379
11	1,958	1,688	1,818	19,122	6,854	8,571	2,030	[a]3,474	1,876	2,651	2,556	4,279
12	1,958	1,583	1,558	18,675	[a]3,490	7,093	1,890	4,454	1,731	1,382	2,129	4,279
13	[a]1,005	1,688	1,818	18,675	7,148	6,159	933	3,931	1,991	[a]1,482	[a]743	4,026
14	2,218	1,583	1,698	[a]18,175	7,946	5,246	[a]1,680	2,911	1,184	2,916	3,029	1,845
15	2,218	1,583	1,818	18,952	9,197	5,076	1,473	2,391	[a]2,834	4,782	2,909	[a]18,680
16	2,088	1,698	1,698	20,735	8,566	[a]3,946	1,770	3,176	3,716	4,782	1,378	20,036
17	2,088	[a]1,140	[a]1,000	21,821	6,854	4,091	1,565	1,382	3,716	4,476	[a]2,231	16,579
18	2,088	1,583	2,148	22,380	6,388	4,093	2,675	[a]2,231	3,176	4,476	2,676	11,954
19	2,218	1,553	1,912	21,821	[a]3,627	3,271	3,210	2,651	2,916	1,869	2,124	8,941
20	1,005	1,583	1,818	22,753	11,611	3,204	1,062	1,851	2,106	[a]2,231	1,864	6,195
21	[a]2,218	1,583	3,023	[a]20,708	9,197	5,097	[a]1,680	1,731	1,258	3,868	1,864	2,443
22	2,218	1,698	3,768	31,890	8,881	5,726	2,865	1,851	[a]791	3,556	1,864	[a]2,834
23	1,863	1,698	4,578	42,820	8,253	[a]4,274	2,675	2,131	2,063	3,146	903	3,518
24	2,078	[a]880	[a]1,126	40,790	7,946	5,986	1,770	1,382	1,991	2,916	[a]1,680	3,994
25	2,078	1,583	4,578	37,036	12,946	5,301	1,770	[a]1,040	1,316	2,771	2,476	1,736
26	2,013	1,583	8,933	31,151	[a]7,662	4,791	1,770	3,602	1,616	1,335	2,384	4,116
27	1,140	1,743	12,270	23,291	6,148	4,791	932	3,436	2,386	[a]1,680	1,864	3,804
28	[a]2,048	1,583	13,126	[a]18,704	6,854	4,648	[a]2,231	3,036	1,259	2,683	1,724	1,538
29	1,443	.....	12,270	17,019	8,565	3,949	3,120	2,651	[a]3,474	2,251	1,724	[a]2,720
30	1,508	.....	12,270	16,056	9,197	[a]3,456	4,072	2,131	1,933	2,251	1,018	1,648
31	1,493	.....	[a]1,045	.....	9,197	.....	4,797	1,262	.....	1,876	.....	3,356
Mean	1,827	1,547	3,445	21,154	8,395	6,256	2,190	2,531	2,463	2,679	2,138	4,771

[a] Sunday.

Mean monthly run-off of Hudson River at Fort Edward, N. Y.

[Drainage area, 2,800 square miles.]

MEAN MONTHLY FLOW IN SECOND-FEET.

Month.	1899.	1900.	1901.
January	3,527	3,211	1,827
February	1,902	7,704	1,547
March	5,005	3,934	3,445
April	16,811	16,914	21,154
May	9,561	6,358	8,395
June	1,617	2,834	6,256
July	1,150	1,248	2,190
August	714	1,652	2,531
September	1,347	1,110	2,463
October	1,033	1,243	2,679
November	5,098	5,077	2,138
December	5,157	5,331	4,771
Year	4,410	4,718	4,950

[a] Water power of Upper Hudson River is described in Report of New York State Engineer and Surveyor, 1895, pp. 124-154.

Mean monthly run-off of the Hudson River at Fort Edward, N. Y.—Continued.

RUN-OFF IN SECOND-FEET PER SQUARE MILE.

Month.	1899.	1900.	1901.
January	1.26	1.15	0.65
February	.68	2.53	.55
March	1.79	1.40	1.23
April	6.00	6.04	7.55
May	3.41	2.27	3.00
June	.58	1.01	2.23
July	.41	.45	.78
August	.26	.59	.90
September	.48	.40	.88
October	.37	.44	.96
November	1.82	1.13	.76
December	1.84	1.18	1.06
Year	1.58	1.55	1.71

RUN-OFF IN INCHES ON DRAINAGE AREA.

January	1.95	1.32	0.75
February	.70	2.63	.57
March	2.05	1.61	1.41
April	6.69	6.74	8.46
May	3.83	2.61	3.45
June	.63	1.13	2.50
July	.47	.51	.90
August	.30	.68	1.03
September	.53	.44	.99
October	.42	.50	1.10
November	2.03	1.26	.85
December	2.12	1.36	1.22
Year	21.72	20.79	23.23

High water of Hudson River at Fort Edward, N. Y.

Date.	Maximum discharge.	Maximum discharge per square mile.
	Second-feet.	*Second-feet.*
April 18, 1896	42,620	15.2
November 7, 1896	24,550	8.7
April 12, 1897	23,732	8.5
June 12, 1897	23,242	8.3
December 17, 1897	27,920	10.0
March 16, 1898	29,856	10.7
April 25, 1898	32,159	11.5
April 23, 1900	43,900	15.7
April 23, 1901	42,820	15.3

HUDSON RIVER AT MECHANICVILLE, SARATOGA COUNTY, N. Y.

A record of the flow of Hudson River at Mechanicville has been kept by the Duncan Company, beginning December, 1888. The rec-

ord includes two daily readings of the depth on the crest of the dam and a continuous record of the run of the water wheels in the adjoining paper mill. The accompanying tables show the monthly and daily mean flow at Mechanicville, computed by Mr. R. P. Bloss, the engineer of the company. A record is kept of the length and height of the flashboards at all times, with the dates of their setting and removal.

The flow over the dam has been computed by the Francis formula for the Merrimac dam: $Q = 3.01\ L\ H^{1.53}$, L being 794 feet. H = depth on crest of dam in feet. The same formula has been used in all cases, whether flashboards are on or off.

The flow through the water wheels has been taken from the rating tables of the manufacturers. The working head on the wheels varies from 15 to 17 feet, depending on the condition of the flashboards on the dam. A test by Mr. Bloss of a 39-inch Hercules wheel in the mill, which has been in use about eight years, shows the actual discharge to be substantially as given in the manufacturers' tables when running at the speed of greatest efficiency. When running at higher speed the discharge may be several per cent less.

A current-meter measurement of the flow below the dam was made at the Mechanicville toll bridge October 20, 1900, showing a discharge of 1,871 second-feet. The result is somewhat uncertain owing to slack water. No water was flowing over the dam, and the calculated turbine discharge was 1,977 second-feet.

The flow of Hudson River at Mechanicville has been calculated, using the East Indian engineers' formula for flow over the dam.[a] This formula gives a somewhat larger discharge than that obtained by using the formula given.

The highest flood since the record has been kept occurred April 19, 1896, and showed a discharge of 59,400 second-feet, or 13.2 second-feet per square mile.

The highest known freshet discharge of Hudson River occurred in the spring of 1869. The calculated discharge at Mechanicville was 70,000 second-feet, or 15.5 second-feet per square mile.[b]

---

[a] See Report of State Engineer and Surveyor of New York, 1895, pp. 104-107.

[b] A list of Hudson River high-water marks is given by C. L. Harrison in Report of U. S. Board of Engineers on Deep Waterways, Pt. 1, pp. 377-378.

Mean daily discharge, in second-feet, of Hudson River at Mechanicville, N. Y., for 1901.

[Drainage area, 4,500 square miles.]

Day	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	[a] 4,094	2,645	[a] 2,281	15,444	19,734	12,179	[a] 3,998	5,689	2,990	3,858	3,315	1,800
2	[a] 3,785	2,525	[a] 2,199	14,154	17,770	10,329	[a] 3,773	4,802	4,734	3,831	3,826	2,453
3	[a] 3,405	[a] 6,097	[a] 3,550	14,395	15,456	11,711	[a] 3,591	4,183	6,220	3,834	2,430	3,631
4	2,880	[a] 2,938	[a] 1,911	17,770	14,533	11,491	[a] 2,491	2,319	6,139	3,269	4,173	3,912
5	2,834	[a] 3,172	[a] 2,742	18,535	14,000	11,374	[a] 4,579	3,733	5,560	3,247	3,770	4,183
6	[a] 2,040	[a] 2,969	[a] 2,530	19,768	11,491	10,379	[a] 3,832	3,186	5,147	2,490	3,875	4,115
7	2,834	[a] 3,508	[a] 2,336	32,284	9,567	10,019	[a] 2,771	3,428	4,433	3,673	3,887	3,785
8	2,903	[a] 2,645	[a] 2,332	37,516	9,354	13,725	[a] 5,072	5,190	2,890	3,706	3,665	3,485
9	2,880	[a] 2,538	2,315	34,262	9,129	12,563	[a] 4,154	5,590	4,094	3,640	3,619	5,752
10	2,927	.....	2,517	31,464	8,195	13,108	[a] 3,719	5,914	3,661	3,527	2,057	5,252
11	[a] 2,966	[a] 3,073	5,971	27,506	8,296	11,374	[a] 3,419	4,675	3,201	3,527	3,785	[a] 8,064
12	2,927	[a] 3,081	10,688	24,819	8,600	9,693	[a] 3,938	6,011	3,218	3,404	3,612	[a] 6,657
13	[a] 2,040	[a] 2,576	5,502	23,572	9,558	8,306	[a] 3,891	5,554	3,340	1,907	5,497	[a] 5,839
14	[a] 3,082	[a] 2,714	4,910	22,290	10,279	7,333	.....	4,856	4,082	4,690	5,442	[a] 6,589
15	[a] 3,103	[a] 2,676	5,062	24,046	10,716	6,135	[a] 3,333	4,065	3,150	6,658	4,970	25,600
16	[a] 2,988	[a] 2,804	4,483	23,034	10,604	4,230	[a] 3,891	4,190	4,902	7,870	5,024	31,889
17	[a] 4,596	[a] 4,279	2,045	24,846	8,316	5,509	[a] 3,858	4,915	5,224	7,382	2,750	22,597
18	[a] 3,966	[a] 2,909	3,535	26,122	9,466	4,692	[a] 2,367	.....	5,867	6,487	4,561	17,061
19	[a] 3,738	[a] 2,737	6,425	26,494	10,700	4,133	3,389	4,710	3,750	.....	4,150	12,995
20	[a] 2,833	[a] 2,490	5,417	25,960	15,456	3,880	4,072	3,733	4,665	4,010	3,882	10,109
21	2,796	[a] 2,647	16,520	24,640	14,029	4,116	2,877	5,682	4,071	5,540	3,585	8,272
22	2,892	[a] 2,189	17,612	41,069	11,819	5,985	4,112	3,181	2,450	4,643	3,495	8,060
23	2,868	1,961	11,386	49,611	11,711	5,100	3,665	5,414	3,834	4,856	3,506	7,371
24	2,858	[a] 3,752	8,988	54,862	11,379	7,140	3,472	4,856	3,576	4,537	1,400	6,038
25	2,846	[a] 2,143	11,251	50,650	10,913	7,040	2,891	4,600	3,342	4,127	3,837	4,956
26	2,846	[a] 2,335	15,495	42,976	9,410	5,878	2,453	6,690	2,858	3,933	3,831	6,464
27	.....	2,096	21,684	33,207	9,565	5,380	2,886	5,540	2,714	.....	3,949	5,154
28	[a] 3,642	[a] 2,465	20,612	23,520	11,946	4,955	1,377	4,859	3,657	4,314	3,722	5,026
29	[a] 3,578	.....	17,659	21,996	13,084	4,185	2,909	4,334	2,450	3,773	3,020	4,694
30	[a] 2,809	.....	16,243	21,246	13,224	2,240	4,997	4,258	4,509	3,518	3,315	12,405
31	2,673	.....	15,186	.....	13,096	.....	5,347	3,675	.....	3,412	.....	8,909
Mean	3,087	2,888	8,095	28,268	11,658	7,806	3,551	4,661	4,024	4,264	3,732	8,491

[a] Record approximate, flashboards irregular.

Mean monthly run-off of Hudson River at Mechanicville, N. Y.

[Drainage area, 4,500 square miles.]

MEAN MONTHLY FLOW IN SECOND-FEET.

Month.	1898.	1899.	1900.	1901.
January	8,173	6,437	5,841	3,087
February	6,038	5,147	12,484	2,888
March	19,617	9,316	7,740	8,095
April	13,047	24,607	22,614	28,268
May	10,525	9,591	8,992	11,658
June	5,069	2,539	4,093	7,806
July	2,751	2,402	2,352	3,551
August	5,029	1,417	2,703	4,661
September	3,810	2,054	1,886	4,024
October	7,516	2,616	2,128	4,264
November	8,978	6,066	5,077	3,732
December	5,291	7,303	5,331	8,491
Year	7,987	6,625	6,770	7,544

RUN-OFF IN SECOND-FEET PER SQUARE MILE.

January	1.81	1.43	1.30	.69
February	1.34	1.14	2.77	.64
March	4.36	2.07	1.72	1.80
April	2.90	5.47	5.02	6.28

Mean monthly run-off of Hudson River at Mechanicville, N. Y.—Continued.

RUN-OFF IN SECOND-FEET PER SQUARE MILE—Continued.

Month.	1898.	1899.	1900.	1901.
May	2.34	2.11	2.00	2.60
June	1.12	.56	.91	1.73
July	.61	.53	.52	.79
August	1.11	.31	.60	1.03
September	.85	.45	.42	.89
October	1.67	.58	.47	.94
November	1.99	1.36	1.11	.83
December	1.17	1.62	1.13	1.88
Year	1.77	1.47	1.50	1.68

RUN-OFF IN INCHES ON DRAINAGE AREA.

January	2.08	1.64	1.50	.79
February	1.39	1.18	2.88	.67
March	5.02	2.38	1.98	2.00
April	3.23	6.12	5.60	7.03
May	2.69	2.43	2.30	2.99
June	1.25	.62	1.01	1.93
July	.70	.61	.60	.91
August	1.28	.35	.69	1.18
September	.95	.50	.47	1.00
October	1.92	.66	.54	1.08
November	2.22	1.56	1.24	.92
December	1.35	1.86	1.36	2.16
Year	24.08	19.91	20.17	22.66

LOWER HUDSON RIVER AND LONG ISLAND SOUND DRAINAGE.

KINDERHOOK CREEK AT EAST NASSAU AND WILSON'S DAM, RENSSELAER COUNTY, N. Y.

Gagings of this stream were conducted by the Albany water department during the years 1892, 1893, and 1894, the results of which are of interest in connection with measurements of surrounding watersheds like Tenmile, Housatonic, and Fishkill, proposed possible sources of municipal supply for New York City.

The original Kinderhook gagings have been furnished for calculation by George I. Bailey, superintendent of the Albany bureau of water.

Kinderhook Creek is an interstate stream having its source in Hancock Mountains, Massachusetts. It flows in a southwesterly direction through Rensselaer and Columbia counties, N. Y., debouching into Hudson River at Stockport. Its tributary drainage is divided between New York and Massachusetts, as follows:

	Square miles.
Drainage in New York	304.7
Drainage in Massachusetts	29.3
Total drainage above mouth	334

A gaging record was kept at a weir erected across the stream above East Nassau, July 28 to November 30, inclusive, 1892. The record included the flow over the thin-edged weir or dam, and the flow in tailrace of the adjoining mill. Readings of the gage height at both dam and race were taken at thirty-minute intervals from 6.30 p. m. to 7 a. m. each day, and the flows for the several one-half hour periods were summated to obtain the total yield during the night.

The measurements in the main stream were taken at a compound weir, consisting of a lower central section 50.17 feet in length, over which the entire flow passed at ordinary stages of the stream; the remainder of the dam, having a length of 92.33 feet, was raised and leveled by means of a 2-inch plank to an elevation 1.20 feet above the central thin plate weir. Whenever the head exceeded 1.2 feet on the lower section the water flowed over the entire dam, 142.5 feet in length. The discharge has been computed by means of the Francis formula, allowing for two complete end contractions for all depths on the lower section.

The drainage area above the East Nassau gaging station is 120.5 square miles.

A second gaging station was established on Kinderhook Creek, at Wilson's mill, below Garfield reservoir, July 14, 1893, and a record maintained from that date until December 31, 1894.

The drainage area above the weir at Wilson's dam is 68.2 square miles, or 57 per cent of that at East Nassau. Readings were taken at this weir at 6 a. m., 12 m., and 6 p. m. of each day.

The principal dimensions of the weir, which was of the compound variety, were as follows:

Dimensions of Wilson's dam, Rensselaer County, N. Y.

	Feet.
Total length of dam	99.22
Length of central lower overflow	25.00
Length of right overflow of main dam	37.95
Length of left overflow, main dam	36.27
Total length of upper overflow	74.22
Difference of elevation of two spillways, July 1 to May 25, 1894	1.00
Difference of elevation of two spillways, May 27 to December 31, 1894	.89

The accompanying tables show the mean daily flow in second-feet at the two Kinderhook stations for the periods during which the records were kept. The summary for Wilson's dam includes the rainfall on the watershed from a private record kept at that station in 1894.

Mean monthly run-off of Kinderhook Creek at East Nassau, N. Y.

[Drainage area, 120 square miles.]

Date.	Maximum.	Minimum.	Mean.	Mean, per square mile.	Run-off on drainage area.
1892.	*Second-feet.*	*Second-feet.*	*Second-feet.*	*Second-feet.*	*Inches.*
August	362.4	37.0	97.8	0.81	0.93
September	134.6	35.0	68.7	.55	.62
October	44.0	28.5	34.7	.29	.33
November	531.5	20.1	121.5	1.01	1.13
1894.					
January			143.7	1.19	1.37
February			74.7	.62	.64
March			351.4	3.74	4.30
April			155.4	1.29	1.44
May					
June			105.2	.87	.97
July			30.5	.25	.29
August			15.5	.13	.15
September			25.4	.21	.24
October			49.4	.41	.46

Mean monthly run-off of Kinderhook Creek at Wilson's dam, New York.

[Drainage area, 68 square miles.]

Date.	Maximum.	Minimum.	Mean.	Mean, per square mile.	Run-off on drainage area.
1893.	*Second-feet.*	*Second-feet.*	*Second-feet.*	*Second-feet.*	*Inches.*
July	53.8	11.8	24.9	0.37	0.43
August	256.4	8.2	44.8	.66	.76
September	191.2	23.6	69.7	1.02	1.14
October	126.6	30.2	64.8	.95	1.09
November	93.2	32.2	55.5	.82	.92
December	338.7	45.3	121.7	1.79	2.06

Mean daily flow, in second-feet, of Kinderhook Creek at East Nassau, for 1892.

[Drainage area, 120 square miles.]

Day.	July.	Aug.	Sept.	Oct.	Nov.	Day.	July.	Aug.	Sept.	Oct.	Nov.
1	.....	125.39	96.72	31.62	31.93	18	.....	47.27	63.08	38.59	281.40
2	.....	86.73	83.39	30.54	30.07	19	.....	50.37	52.23	38.13	329.28
3	.....	69.42	69.44	31.62	40.61	20	.....	89.59	44.33	42.78	238.42
4	.....	59.90	63.39	31.93	51.93	21	.....	46.65	.....	38.13	189.39
5	.....	53.35	58.12	32.55	95.79	22	.....	45.10	48.05	34.56	166.73
6	.....	47.11	134.69	44.02	65.41	23	.....	44.33	40.30	33.63	144.77
7	.....	46.96	102.92	43.71	52.08	24	.....	39.99	92.38	32.24	119.04
8	.....	40.40	76.72	34.25	51.15	25	.....	46.65	107.42	28.52	99.51
9	.....	37.28	61.69	41.23	47.74	26	.....	362.39	61.69	28.67	96.72
10	.....	61.15	58.12	33.79	59.83	27	.....	294.76	49.14	30.38	97.34
11	.....	81.74	51.61	31.46	76.10	28	32.24	187.75	39.22	30.85	88.19
12	.....	273.54	44.48	35.18	72.07	29	37.20	142.60	35.03	30.23	90.67
13	.....	159.68	39.22	36.27	65.87	30	101.37	99.51	36.58	31.62	91.76
14	.....	110.67	111.14	36.12	61.69	31	84.94	96.72	.....	30.85	.....
15	.....	78.95	126.32	36.12	58.12						
16	.....	66.03	76.88	38.28	221.25	Mean	63.09	97.08	68.07	34.07	121.05
17	.....	56.73	67.89	37.97	531.48						

Mean daily flow, in second-feet, of Kinderhook Creek at Wilson's dam, New York, for 1893.

[Drainage area, 68 square miles.]

Day.	July.	Aug.	Sept	Oct.	Nov.	Dec.	Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	33.0	15.2	60.9	90.7	73.2	68.8	18	20.3	11.3	103.1	50.1	45.1	241.4
2	53.8	13.0	47.4	71.5	64.9	56.6	19	17.2	11.1	109.7	47.1	47.1	165.6
3	36.1	12.3	38.4	60.0	68.5	67.1	20	15.1	33.6	128.8	44.8	43.6	110.8
4	31.8	11.2	35.7	56.0	73.8	158.1	21	12.5	12.2	87.9	32.4	42.3	127.7
5	29.9	10.9	31.5	53.6	73.9	101.4	22	13.5	10.3	70.4	30.2	51.3	155.0
6	25.9	10.2	27.7	49.9	65.9	97.5	23	13.9	9.1	63.9	46.3	54.7	149.4
7	22.0	30.0	38.1	66.8	60.3	93.2	24	13.0	82.6	57.5	66.8	47.3	147.9
8	26.5	50.7	81.7	63.1	58.7	80.1	25	11.8	133.9	61.4	58.9	41.2	171.9
9	36.7	30.1	53.6	51.9	54.6	80.0	26	21.2	94.1	68.4	51.3	32.4	172.6
10	27.0	19.5	37.7	47.3	50.7	83.2	27	40.0	64.3	56.4	55.2	42.2	136.2
11	22.0	14.5	31.9	55.5	47.4	67.7	28	24.6	154.1	50.1	126.6	89.0	119.2
12	27.6	13.4	28.1	50.2	46.2	63.6	29	20.0	256.4	134.4	120.3	93.2	123.8
13	47.9	11.2	26.0	61.7	46.0	47.0	30	19.7	167.2	128.5	96.6	78.6	126.2
14	30.4	10.4	23.6	111.6	45.4	45.3	31	16.7	88.7	.....	83.9	.....	96.3
15	23.6	9.2	61.7	85.9	42.8	67.6							
16	21.1	8.3	191.2	66.2	42.2	211.2	Mean	25.0	44.8	69.8	64.8	55.5	121.7
17	19.8	9.2	156.3	58.0	43.2	338.7							

Mean daily flow, in second-feet, of Kinderhook Creek at Wilson's dam, New York, for 1894.

[Drainage area, 68 square miles.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	76.9	66.0	40.9	93.9	67.4	98.9	15.5	13.8	5.5	9.3	73.8	57.2
2	77.2	59.5	49.6	83.2	61.2	96.7	14.1	12.0	4.1	9.9	51.9	56.0
3	81.8	63.2	66.2	73.2	57.8	90.8	17.2	12.9	6.6	15.7	133.1	51.5
4	88.5	58.0	96.6	87.1	58.1	80.8	18.9	16.6	6.7	35.0	164.5	53.9
5	115.5	45.0	156.5	101.2	63.2	67.3	17.8	14.5	7.2	34.7	130.5	57.5
6	113.9	45.1	315.9	88.2	62.9	60.8	25.9	13.0	6.1	29.1	159.8	48.4
7	91.9	47.6	608.9	80.1	87.7	55.6	48.8	9.1	6.1	23.6	124.1	49.8
8	84.3	49.8	457.1	82.2	74.9	58.3	29.9	8.1	6.6	18.0	104.2	45.9
9	77.0	49.8	343.4	84.9	56.7	51.0	23.1	9.6	8.9	18.4	96.0	44.3
10	71.0	47.6	305.4	86.4	48.2	43.2	17.4	8.9	13.1	39.5	95.9	48.2
11	71.1	45.6	325.6	78.4	47.1	39.8	14.3	8.4	17.2	68.5	90.7	48.7
12	53.3	36.9	330.4	76.4	48.2	37.5	17.4	7.9	13.1	49.0	75.6	288.2
13	44.8	33.0	267.9	76.9	40.8	32.6	14.8	8.3	10.6	43.7	65.4	452.0
14	67.7	45.0	232.3	76.3	38.0	34.4	13.2	8.0	12.4	41.5	66.7	270.7
15	78.6	43.1	189.0	70.1	37.4	26.5	13.7	19.9	14.9	44.8	65.7	189.3
16	160.6	39.1	160.6	64.3	34.4	25.9	13.4	11.3	15.2	34.9	83.1	169.4
17	118.3	39.7	150.7	61.2	30.8	23.4	12.6	9.4	22.5	29.1	104.8	185.9
18	79.2	55.7	155.7	59.1	36.3	23.9	12.1	7.8	19.8	76.2	100.3	163.4
19	81.2	74.1	190.4	58.9	46.8	40.9	10.8	6.8	20.0	26.0	85.6	135.8
20	66.0	63.9	204.4	68.8	40.8	78.7	10.7	8.2	54.6	21.7	75.8	123.4
21	78.7	52.7	167.7	123.8	33.6	67.0	12.3	8.2	37.5	19.1	66.5	111.9
22	72.9	44.6	163.9	129.6	31.6	51.8	22.6	8.5	24.2	19.2	64.5	109.4
23	62.6	40.8	234.6	151.6	37.4	36.1	17.7	5.8	16.6	19.4	65.6	87.0
24	73.0	33.5	220.8	143.8	63.4	27.1	13.1	7.2	16.1	20.6	98.4	70.4
25	129.6	37.8	175.6	123.5	81.2	22.9	13.0	6.1	14.7	23.7	95.3	78.6
26	88.7	36.1	144.5	105.7	72.4	22.0	10.5	5.4	12.4	28.4	82.6	57.8
27	83.5	33.3	107.6	91.8	58.8	22.9	10.1	5.3	11.7	25.9	77.7	38.3
28	68.8	35.0	91.3	84.5	70.4	22.2	8.7	5.7	11.2	22.2	65.9	48.4
29	59.1	.....	88.8	78.3	160.8	19.1	14.5	5.4	10.1	19.1	46.5	51.8
30	60.1	.....	83.4	73.8	112.4	16.3	36.0	5.7	9.1	16.6	51.5	52.9
31	64.5	.....	84.0	.....	98.9	.....	21.1	7.0	.....	40.9	.....	54.7
Mean	81.8	42.6	200.3	88.7	60.0	45.7	17.5	8.9	14.5	28.2	88.9	125.3

Mean monthly run-off of Kinderhook Creek at Wilson's dam, New York, for 1894.

[Drainage area, 68 square miles.]

Month.	Maximum.	Minimum.	Mean.	Mean per square mile.	Run-off on drainage area.	Rainfall at Wilsons dam.	Ratio of run-off to rainfall.
	Sec. feet.	*Sec. feet.*	*Sec. feet.*	*Sec. feet.*	*Inches.*	*Inches.*	
January	160.6	44.8	81.8	1.20	1.38	2.14	0.64
February	74.1	33.0	42.6	.63	.66	1.36	.21
March	608.9	40.9	200.3	2.94	3.38	.28	12.07
April	151.6	58.9	88.7	1.30	1.46	1.23	1.19
May	160.8	30.8	60.0	.88	1.01	4.35	.23
June	98.9	16.3	45.7	.82	.92	2.40	.42
July	48.8	8.7	17.5	.26	.30	3.33	.09
August	16.6	5.2	8.9	.13	.15	.70	.21
September	54.6	4.1	14.5	.21	.24	3.15	.07
October	68.5	9.3	28.2	.41	.47	4.14	.11
November	164.5	46.5	88.8	1.31	1.47	2.40	.61
December	451.1	44.0	125.3	1.85	2.13	2.51	.85
Year	608.9	4.1	66.9	1.00	13.57	27.99	0.49

NORMANSKILL CREEK AT FRENCH'S MILL, ALBANY COUNTY, N. Y.

The Normanskill drains an area of 168 square miles, lying between the Lower Mohawk watershed and the northern drainage slope of the Catskill Mountains, and including a portion of the counties of Albany and Schenectady. The stream enters tide water of Hudson River at Kenwood, a suburb of Albany. A gaging record showing the flow of this stream from June 1 to December 1, 1891, is of interest in connection with measurements of flow from the adjacent Catskill and Schoharie watersheds, proposed as possible sources of supply for Greater New York. The volume of flow was determined by means of weirs erected at French's mill by the bureau of water of Albany. Mr. George I. Bailey, superintendent of the bureau, has furnished the original records for computation. The stream is at an elevation of 200 feet above tide at the point where gaged, and receives the drainage from an area of 110.6 square miles, or 66 per cent of the entire watershed.

Below French's mill the stream follows a tortuous valley, relatively deep and narrow, its banks rising abruptly from the flood plain. The topography of the lower Normanskill is shown on the Albany sheet of the Geological Survey.

Mean monthly run-off of Normanskill Creek at French's mill, New York.

[Drainage area, 111 square miles.]

Date.	Maximum.	Minimum.	Mean.	Mean, per square mile.	Run-off depth on drainage area.
1891.	*Second-feet.*	*Second-feet.*	*Second-feet.*	*Second-foot.*	*Inch.*
June	44.6	10.1	26.2	0.24	0.27
July	18.1	7.3	10.2	.09	.10
August	16.7	5.9	8.7	.08	.09
September	18.4	4.6	8.1	.07	.08
October	34.1	4.9	10.6	.10	.11
November	142.0	6.9	21.7	.20	.22
December	84.3	18.0	57.2	.51	.59

Mean daily flow, in second-feet, of Normanskill Creek at French's mill, for 1891.

[Drainage area, 111 square miles.]

Day.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	25.6	10.4	8.8	8.2	9.0	8.0	20.2
2	20.3	14.5	8.5	18.4	10.1	9.8	18.9
3	44.6	12.8	12.7	12.2	7.8	8.0	18.0
4	44.6	11.4	8.7	9.4	4.9	9.7	24.5
5	44.6	11.4	16.9	9.1	7.9	8.1	226.9
6	31.5	10.4	12.0	14.2	7.1	9.0	119.5
7	24.2	10.1	9.1	10.0	6.7	8.0	95.0
8	18.4	14.5	8.9	8.5	34.1	7.0	73.6
9	18.3	12.0	8.5	7.6	15.1	8.4	51.2
10	17.2	9.3	8.8	7.2	9.9	11.3	49.4
11	18.3	9.3	8.3	6.2	8.8	8.1	44.0
12	37.8	9.0	10.9	6.5	10.6	16.7	39.8
13	23.9	8.1	8.8	6.8	8.7	14.2	29.6
14	24.2	7.5	7.9	9.1	9.5	13.0	27.4
15	22.2	8.1	7.7	7.7	8.5	9.8	26.7
16	22.3	7.8	7.9	7.1	9.3	10.6	67.3
17	17.2	7.5	7.2	7.1	8.1	11.5	47.9
18	33.5	7.4	7.2	7.5	6.1	25.3	51.6
19	36.0	10.7	7.2	7.5	10.2	16.2	49.6
20	37.5	9.2	6.7	6.2	8.8	14.4	38.0
21	35.3	18.3	6.8	7.2	23.4	15.3	32.7
22	33.5	9.9	6.5	6.1	12.1	13.7	31.8
23	31.5	9.6	6.2	7.1	13.1	18.1	137.2
24	29.5	11.8	6.6	6.5	11.6	142.9	479.5
25	20.9	11.2	7.2	7.1	9.1	75.8	502.5
26	19.7	10.7	5.9	7.7	9.9	46.3	391.8
27	18.3	9.2	9.3	5.4	10.1	40.1	279.1
28	16.3	7.9	16.1	5.6	9.6	35.4	129.3
29	10.4	8.3	9.0	4.7	8.7	22.7	70.5
30	10.1	8.1	7.9	6.8	9.1	18.7	858.8
31	.....	10.5	8.4	.....	9.3	.....	.....
Mean	26.2	10.2	8.7	8.1	10.6	21.7	57.2

GAGINGS OF STREAMS PROPOSED AS SOURCES OF PUBLIC WATER SUPPLY FOR NEW YORK CITY.

Through the cooperation of the department of water supply of New York, George W. Birdsall, chief engineer, a series of gagings of streams which have been proposed as possible sources of future municipal water supply for Greater New York have been undertaken. The gagings include streams draining, for the most part, timber-covered mountainous areas in southeastern New York on both the Catskill and Connecticut sides of the Hudson River.

In June, 1901, a reconnaissance was made of Catskill and Esopus creeks, Wallkill River and Rondout Creek, west of the Hudson, and Fishkill Creek and Tenmile River, east of the Hudson, by H. A. Pressey and R. E. Horton. Nearly the entire length of each stream was traversed and a site for a gaging station selected on each. Early in July the stations were established, with the exception of that on Tenmile River. Persons living near at hand were employed as gage readers, to take observations of the stage of the stream twice each day. A. E. Place was in charge of these stations until September, 1901, when W. W. Schlecht took charge as resident hydrographer.

One object of the gagings has been to determine the available run-off for storage of the several streams at sites selected for storage reservoirs.[a] It was not practicable in most cases to locate a gaging

[a] These reservoirs are described in the report on New York's water supply, by John R. Freeman.

station precisely at the foot of the watershed tributary to the proposed reservoir. The relation between the estimated drainage areas at the reservoir sites and at the gaging station on each stream is shown below:

Drainage area at gaging stations.

Stream.	Location of gaging station.	Drainage area.		
		Above proposed reservoir.	Above gaging station.	Above mouth.
		Sq. miles.	*Sq. miles.*	*Sq. miles.*
Tenmile River	Dover Plains, N. Y	200	195	195
Housatonic River	Gaylordsville, Conn	1,020	1,020	1,580
Catskill Creek	South Cairo, N. Y	140	260	394
Esopus Creek	Kingston, N. Y	242	312	417
Wallkill River	New Paltz, N. Y	464	735	779
Rondout Creek	Rosendale, N. Y	184	365	*a* 369
Fishkill Creek	Glenham, N. Y	158	198	204

a Above junction with Wallkill River.

The gagings at each of the stations referred to in the table are made by means of the current meter. The stations were established by R. E. Horton, and the discharge measurements have mostly been made by A. E. Place and W. W. Schlecht. Velocity observations are taken at horizontal intervals of 5 feet across the entire width of the channel, the current meter being submerged 0.6 depth of the sounding at each 5-foot station. In order to determine whether the velocity so obtained is the true mean velocity desired, observations of velocities in vertical planes have been taken at intervals of 0.5 foot of depth from surface to bottom. At a number of the stations the stream bed consists of rock strata overlain by inwashed sand or gravel. The vertical velocity observations are repeated from time to time to determine whether these deposits have shifted in position in such a way as to sensibly affect the rating curve of the cross sections. During the winter similar vertical velocity curves will be obtained to determine the effect of the increased wetted perimeter due to ice.

Wallkill, Housatonic, and Tenmile rivers are interstate streams. The first receives tributary drainage from New York, but does not itself flow through New York State. Tenmile River lies mostly in New York, though the lower few miles of its course and its mouth are in Connecticut. Wallkill River has its headwaters in New Jersey, but the most of its channel and watershed, as well as its outlet, are in New York.

The results of gagings at a station on Housatonic River, established in 1900 by the United States Geological Survey, and of gagings of Croton River by the department of water supply of New York, have been included in this division of the report.

CATSKILL CREEK AT SOUTH CAIRO, GREENE COUNTY, N. Y.

The drainage basin of this stream receives the run-off from the north slope of the Catskill Range, and lies, for the most part, in the timbered highlands of Greene County. Its source is in a swamp at Franklinton, the opposite side of which drains into Schoharie Creek. The stream enters tide water of Hudson River at Catskill, the lowest 2 miles of its course, below the influx of Kaaterskill Creek, being slack water. From Kaaterskill Creek to Leeds, a distance of 3 miles, it flows through a gorge formed of tilted strata of bluestone, affording within this distance a fall of 180 feet. The topography of the watershed is shown on the Durham, Coxsackie, and Catskill atlas sheets of the United States Geological Survey. The stream flows over a rock bed through much of its course. The slopes of the drainage basin are precipitous, and there are no lakes and little artificial storage. The stream is subject to wide variations in flow. High-water marks observed at the Woodstock dam indicate a freshet discharge in the spring of 1901 of 21,000 second-feet, or 100 second-feet per square mile from the tributary drainage area of 210 square miles.

The principal tributary of Catskill Creek above the station at South Cairo is Basic Creek, entering at Freehold. The reported high-water mark on the dam at Freehold indicates a maximum freshet discharge for Basic Creek of 3,330 second-feet, or 81 second-feet per square mile from the tributary drainage area of 41 square miles.

The gaging station is located at the highway bridge in the village of South Cairo, and was established July, 1901. A 15-foot boxed weight gage, divided to feet and tenths, was fastened to cross pieces on horizontal chords of the second section of bridge from the right bank, downstream side. The total span of the bridge is 194.5 feet between abutments, the faces of which are vertical. The stream bed is of earth for 25 feet from the right-hand abutment. At this point a bluestone-rock ledge outcrops, covered in patches with loose shingle and shifting gravel. The bench mark is an "0" near outer corner, upstream side of bridge seat, on right-hand abutment.

Elevation of bench mark	100.00
Elevation water surface when gage reads zero	78.71
Center of highway 50 feet to left of end of bridge	97.11

The entire flow of the stream at all stages passes under this bridge. High-water marks observed at the bridge indicate a maximum elevation of the water surface of 96.2 feet, equivalent to a gage reading 17.5 feet. The stage of the stream is observed each morning and evening by the gage reader, Mr. C. F. Abrams. The following table shows the results of discharge measurements which have been made. During extreme low water the current-meter measurements are made by wading at a point 400 feet below the gaging station.

Table showing principal developed water powers on Catskill Creek in 1901.

No. of dam.	Location.	Name of mill and of owner or operator.	Business or class of manufacture.	Working head on water wheels. Greatest.	Least.	Average.	Water privilege at dam.	Rated power of water wheels at usual head (horsepower).	Horsepower of engines.
				Ft.	*Ft.*	*Ft.*			
1	Leeds	Catskill Woolen Mill.[a]	Woolen and cotten fabrics.	26	12	8	Entire	200	60
2	do	Waterville Woolen Mill.[a]	do	19	4	14	do	200	80
3	Lakes Mills	Lakes Mills	Gristmill				do		
4	Woodstock	Woodstock Paper Mill.[b]	Paper mill	24	10		do		
5	Freehold[c]	Brown's Mill	Gristmill	12	10	11	do	15 20	None
6	Greenville[c]	Reed's Mills	do			22	do	22	8
7	East Durham	Not reported[d]	do			16	do		
8	do[c]	Atter Bros.	Saw and feed mill	30			do	30	
9	do	([d])				10	do		

[a] Mill not operated.
[b] Mill abandoned.
[c] Basic Creek, tributary Catskill, at Freehold.
[d] Abandoned, Glenbrook Stream.
[e] Glenbrook Stream.

Daily gage height, in feet, of Catskill Creek at South Cairo, N. Y., for 1901.

Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1		2.55	2.92	2.8	2.7	2.65	17	3.55	2.4	2.82	3.02	2.77	5.00
2		2.6	3.00	2.75	2.7	2.65	18	3.78	2.52	2.97	2.97	2.75	4.49
3		2.55	3.22	2.7	2.65	2.65	19	4.35	2.62	2.97	2.9	2.75	4.00
4	2.75	2.4	3.27	2.7	2.67	3.30	20	3.58	2.67	2.82	2.85	2.75	3.85
5	2.9	2.4	3.05	2.67	2.67	3.30	21	3.17	2.75	2.8	2.82	2.75	3.90
6	3.3	2.5	2.92	2.67	2.65	3.32	22	2.67	3.05	2.8	2.8	2.75	4.00
7	3.6	3.35	2.87	2.62	2.7	3.32	23	2.95	3.22	2.77	2.8	2.70	4.00
8	3.63	3.05	2.9	2.65	2.7	3.30	24	3.0	3.45	2.72	2.8	2.70	4.07
9	3.35	2.87	2.87	2.6	2.65	3.35	25	3.02	3.55	2.62	2.8	2.70	3.45
10	3.075	2.8	2.82	2.65	2.65	5.35	26	2.82	3.2	2.65	2.8	2.70	3.45
11	3.53	2.77	2.8	2.6	2.65	4.62	27	2.7	2.95	2.65	2.75	2.65	3.40
12	3.43	2.65	2.75	2.6	2.67	4.45	28	2.7	2.8	2.7	2.75	2.65	3.50
13	3.23	2.55	2.77	2.65	2.8	3.95	29	2.72	2.7	2.8	2.75	2.65	3.85
14	3.00	2.5	2.72	2.8	3.02	6.95	30	2.65	2.65	2.82	2.7	2.65	4.50
15	2.85	2.5	2.7	3.1	2.85	12.80	31	2.6	2.6		2.7		4.40
16	2.9	2.5	2.75	3.15	2.82	5.60							

Current-meter discharge measurements of Catskill Creek at South Cairo, N. Y.

Date.	Mean gage height.	Discharge.	Hydrographer.
1901.	*Feet.*	*Second-feet.*	
October 10	2.58	23.3	Hollister and Schlecht.
October 4	2.70	25.6	W. W. Schlecht.
November 8	2.70	27.6	Do.
August 19	2.70	39.6	Hollister and Place.
September 23	2.74	35.6	W. W. Schlecht.
November 9	2.75	42.3	Do.
July 4	2.75	60.9	Horton and Hollister.
August 1	2.80	47.9	A. E. Place.
October 22	2.82	54.2	W. W. Schlecht.
September 7	2.92	68.8	A. E. Place.
August 9	3.00	81.5	Do.
July 25	3.00	81.9	Do.
September 2	3.00	87.0	Do.
August 27	3.12	121.4	Do.
July 17	3.50	260.3	Pressey and Place.
July 20	3.60	307.5	A. E. Place.

A gaging was made through ice 0.2 to 0.7 foot thick at a point 200 feet below the highway bridge by W. W. Schlecht, December 9, 1901.

Gage height		3.30
Discharge	second-feet	109.5

ESOPUS CREEK AT KINGSTON, ULSTER COUNTY, N. Y.

Esopus Creek has its source in Winnisook Lake on the northwestern slope of Slide Mountain, the highest peak of the Catskills.

From Big Indian to Olive Bridge the stream flows through a deep valley, flanked on both sides by timber-covered mountains. Numerous sites for dams or storage reservoirs are offered at points where the valley broadens out for a short distance to receive the inflowing waters of tributaries. The most notable are at Big Indian, where Birch Creek enters; at the mouth of Bush Kill, at Shandaken; at the mouth of Stony Clove Creek, at Phoencia; at Coldbrook, where Little Beaver Kill enters; and at Olive Bridge. The stream channel is relatively broad and shallow. The bed is covered with cobble and small bowlders left behind after the erosion of drift deposits which formerly filled the valley. The descent of the stream is rapid though not precipitous until Olive Bridge is reached. At this point the stream flows over a rock ledge in a narrow gorge forming Bishops Falls. The natural fall is 22 feet, and is increased to 28 feet by a timber dam on the crest of the ledge. This dam was originally constructed in 1828. High-water marks at Olive Bridge, just below the falls, indicate that the stream is subject to fluctuations of stage of 30 feet or more in a gorge 100 feet wide. Below Bishops Falls the stream flows through a narrow gorge for some distance, after which the valley broadens out and the slopes become more gentle.

At Kingston the stream turns northward and flows parallel to Hudson River to Saugerties. A second notable waterfall occurs at Glen Erie, where a short cascade occurs, involving a fall of 56 feet. The final descent to tide water at Saugerties is made through a fall of 42 feet.

The gaging station was established at Washington avenue bridge in Kingston July 5, 1901. This bridge has a clear span of 116.6 feet between abutments, which are nearly vertical. In addition, there is on the left-hand side an overflow channel 19 feet in width. A boxed weight gage, reading from zero to 15 feet, with the scale graduated to tenths of feet, was secured to the horizontal bridge chords on the upstream side near the left-hand end of the bridge. Gage readings are taken each morning and evening. The observer is John Douglas. A circular chisel draft cut in the corner of the coping of the right-hand abutment forms the bench mark.

Elevation of bench mark	100.00
Elevation of water surface when gage reads zero	68.27

Owing to unfavorable conditions at the bridge, gagings during extreme low water and during freshets are made, the former by wading at a point near the bridge and the latter at the Ulster and Delaware Railroad bridge, one-fourth mile upstream. The maximum stage of the stream corresponds to a gage reading of nearly 25 feet. December 15, 1901, the stream attained a maximum gage reading of 22.75 feet.

Daily gage height, in feet, of Esopus Creek at Kingston, N. Y., for 1901.

Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	..	3.97	6.47	4.52	4.62	4.60	17	4.05	4.37	5.0	4.47	4.30	10.55
2	..	3.95	6.3	4.62	4.52	4.52	18	4.05	4.55	5.27	4.42	4.37	9.05
3		3.9	6.67	4.7	4.35	4.77	19	4.6	4.5	5.07	4.6	4.52	8.10
4		4.95	6.27	4.52	4.37	5.45	20	4.15	4.77	4.35	4.77	4.50	8.00
5	4.3	3.95	5.8	4.42	4.55	4.62	21	4.1	5.95	5.17	4.77	4.47	7.75
6	4.35	3.7	5.57	4.3	4.47	4.67	22	3.9	6.62	4.77	4.67	4.52	7.20
7	4.3	3.95	5.42	4.47	4.57	4.72	23	4.05	5.92	4.92	4.67	4.45	6.85
8	4.4	7.0	5.02	4.57	4.47	4.65	24	4.0	7.35	4.77	4.62	4.52	6.70
9	4.4	5.72	5.17	4.5	4.32	.....	25	3.9	7.67	4.5	4.62	4.62	6.50
10	4.25	5.17	4.95	4.52	4.32	5.60	26	3.97	6.52	4.37	4.52	4.60	6.35
11	4.25	5.05	5.02	4.47	4.45	11.50	27	3.92	6.02	4.5	4.42	4.57	6.25
12	4.3	4.87	4.87	4.4	4.57	9.72	28	3.85	5.87	4.72	4.45	4.77	6.00
13	4.3	4.72	4.9	4.5	4.60	7.35	29	3.72	5.72	4.45	4.57	5.45	7.55
14	4.2	4.6	4.87	4.52	4.45	8.12	30	4.2	5.45	4.42	4.47	4.52	11.65
15	3.95	4.42	4.72	4.57	4.37	21.38	31	4.25	5.22	.....	4.6	.....	9.45
16	4.2	4.42	4.75	4.65	4.43	15.20							

Current-meter discharge measurements of Esopus Creek, at Kingston, N. Y.

Date.	Gage height.	Discharge.	Hydrographer.
1901.	*Feet.*	*Second-feet.*	
August 5	3.60	39.9	A. E. Place.
July 22	3.80	64.2	Do.
July 18	4.10	144.9	Do.
July 5	4.32	148.0	Horton and Hollister.
July 19	4.40	172.7	A. E. Place.
November 18	4.45	126.5	W. W. Schlecht.
September 26	4.55	167.8	Do.
Do	4.55	150.4	Do.
August 19	4.60	180.2	Hollister and Place.
October 10	4.62	165.8	W. W. Schlecht.
Do	4.62	188.1	George B. Hollister.
October 8	4.70	178.2	W. W. Schlecht.
November 1	4.74	184.3	Do.
November 14	4.75	195.4	Do.
September 21	4.78	200.3	Do.
August 10	4.85	239.2	A. E. Place.
November 26	5.06	244.7	W. W. Schlecht.
October 3	5.26	329.4	Do.
September 6	5.46	352.2	A. E. Place.
August 29	5.50	364.3	Do.
October 21	5.56	380.8	W. W. Schlecht.
August 8	5.65	396.1	A. E. Place.
September 4	6.11	554.3	Do.
August 27	6.26	728.6	Do.
October 16	6.64	785.2	W. W. Schlecht
December 19	8.35	1,472.0	Do.
December 11	11.46	1,720.8	Do.[a]
December 30	12.15	3,989.0	Do.

[a] Backwater from ice dam 300 yards downstream.

Drainage areas of Esopus Creek.

Location.	Area.
	Sq. miles.
Above mouth at Saugerties	417
Above Glen Erie Falls	409
Above gaging station, Kingston	312
Above Bishops Falls, Olive Bridge	234

Esopus Creek was measured by E. G. Paul at Broadhead's bridge August 14, 1900. The discharge was 92 second-feet.

From a report of M. E. Evans, civil engineer, to the Saugerties Manufacturing Company in 1899 the following estimate of the mean flow of Esopus Creek during the several months of the dryest year has been taken. The method of obtaining these results is not stated:

Mean flow of Esopus Creek.

Month.	Flow.	Flow per square mile.	Month.	Flow.	Flow per square mile.
	Second-feet.	*Second-feet.*		*Second-feet.*	*Second-feet.*
January	586	1.41	July	98	0.24
February	705	1.69	August	147	.35
March	733	1.76	September	152	.36
April	658	1.58	October	244	.58
May	442	1.06	November	456	1.09
June	304	.73	December	489	1.17

Mr. Evans states that on December 10, 1878, occurred the highest known freshet in the stream. This resulted from a snow fall of 6 inches, followed by continuous excessive rains for three days, terminating in a downpour of unusual severity. The stream flowed in its highest stage 13 to 14.5 feet in depth over the crest of the dam 330 feet in length, indicating a flood discharge of from 50,000 to 60,000 second-feet, or from 120 to 145 second-feet per square mile.

Water is diverted from Sawkill Creek, a tributary of Esopus Creek, for the supply of Kingston. Sawkill Creek has its source in Echo Lake, 2,060 feet above tide, and flows southeasterly, entering Esopus Creek 4 miles below the city of Kingston. Its channel is very precipitous, and numerous waterfalls occur. Two reservoirs have been constructed, the lower one at an elevation of 350 feet above tide. The amount of diversion varies from 1.5 to 3 second-feet.

Gagings of Sawkill Creek by William R. Hutton indicate the flashy and torrential character of the run-off from Esopus watershed.[b] Mr. Hutton's measurements showed a minimum discharge of 1.5 second-feet at a point 1.5 miles above the mouth. In April, 1895, the melting of a 12-inch fall of snow, occasioned by warm winds and heavy rain, produced a flow of nearly 8,000 second-feet estimated discharge over

[b] Water-Supply and Irrigation Paper, U. S. Geol. Survey, No. 35, pp. 61-62.

the spillway of the lower reservoir. In 1896 it is estimated that a similar flood furnished over 8,000 second-feet. These extreme floods are of very short duration, the water remaining at its maximum stage not more than an hour or so. The drainage area above the point where the measurements were made is 35 square miles.

Estimated extremes of discharge of Sawkill Creek.

	Discharge.	Discharge per square mile.
	Second-feet.	*Second-feet.*
Minimum	1.25	0.036
Maximum	8,000.00	229.000

Principal developed water power on Esopus Creek in 1901.

Location.	Name of mill and of owner or operator.	Business or class of manufacture.	Working head on water wheel.			Water privilege at dam.	Rated power of water wheel at usual head (horsepower).	Horsepower of engines.
			Greatest.	Least.	Average.			
			Ft.	*Ft.*	*Ft.*			
Saugerties	Diamond Paper Co. (Sheffield establishment).[a]	Tissue paper	42	28	35	Leased	607	425
Do	Saugerties Mfg. Co. (Sheffield establishment).	Blank books	28	14	21	do	90	
4 miles above Saugerties.	Legg's mill	Gristmill						
Glen Erie	Ulster White Lead Co.[b]	White lead	56		56	Entire		None.
Olive bridge, right bank.	Boice gristmill	Gristmill	28		22	One-half		None.
Olive bridge, left bank.	De Wett's mill (leased to Hudson Pulp Co).[c]	Sawmill	28		22	do		None.
Brown station	Hudson River Pulp Co.	Pulp mill		([d])		Entire		
Boiceville	J. E. Hornbeck	Excelsior	10	8	9	do	90	20
Phoenicia	Mrs. De Mott	do			6	do		
Big Indian	R. & T. C. Wey	Sawmill			18	do	60	None.
Pine Hill[e]	Geo. Rose Turning Mill.	Wood turning			10	do		None.

[a] Operated 24 hours per day.
[b] Idle since 1893.
[c] Not operated.
[d] Good fall.
[e] On Birch Creek.

RONDOUT CREEK AT ROSENDALE, ULSTER COUNTY, N. Y.

Rondout Creek has its source in the heart of the timber-covered mountain group forming Wittemberg Chain. It flows southeasterly to Napanock, where it encounters the foot of Shawangunk Range, turns abruptly to the northeast and enters the Hudson River at Rondout. Its watershed on the south is very restricted, as it is separated from the Wallkill River only by the narrow Shawangunk Ridge. Notable waterfalls occur at Honk Falls and Napanock over Hudson River shale and on Good Beer Kill above Ellenville. On Good Beer Kill there is a total fall of 870 feet from the Cape, 3 miles above Ellenville,

to Ellenville. Of this about 200 feet are concentrated in a series of cascades called Hanging Rock Falls.

Water power was originally developed at Napanock in 1754. At present there are 5 dams in this village utilizing a total fall of 115 feet. A series of cascades, involving a descent of about 50 feet, occurs at High Falls, where the water flows over Rosendale cement rock.

The gaging station was established at the highway bridge in Rosendale, 3 miles above the junction with the Wallkill, July 6, 1901. Readings of the river stage are taken each morning and evening by A. E. Huben. A 15-foot decimal scale in a wooden box, with weight and wire for observing the gage height, is supported by outriggers fastened to the chords and floor beams near the center of the downstream side of the bridge. The bridge has a single span of 136 feet. The bed of the channel is rock, and the entire flow, aside from diversion to the Delaware and Hudson Canal, described elsewhere, passes under the bridge at all stages. The current is sluggish during extreme low water. Gagings of low stages of the stream are made by wading at a ford 1 mile downstream. The bench mark is a "0" cut in the upstream corner of the bridge seat, right-hand abutment.

Elevation bench mark	100.00
Elevation water surface when gage reads zero	67.97

Drainage areas of Rondout Creek.

Location.	Area.
	Sq. miles.
Above Honk Falls	88
Above High Falls	339
Above gaging station, Rosendale	365
Above junction with Wallkill River	369
Below junction with Wallkill River	1,148
Above mouth at Rondout	1,164

Current-meter discharge measurements of Rondout Creek at Rosendale, N. Y.

Date.	Gage height.	Discharge.	Hydrographer.
1901.	*Feet.*	*Second-feet.*	
July 18	6.30	118.2	A. E. Place.
August 6	6.40	99.4	Do.
November 7	6.42	138.2	W. W. Schlecht.
September 24	6.45	139.6	Do.
October 11	6.47	163.2	Do.
Do	6.47	201.8	G. B. Hollister.
November 16	6.55	183.0	W. W. Schlecht.
July 6	6.55	319.0	Horton and Hollister.
August 15	6.55	225.4	A. E. Place.
October 7	6.60	217.5	W. W. Schlecht.
December 6	6.80	221.8	Do.
September 7	6.90	426.7	A. E. Place.
August 10	6.94	526.4	Hollister and Place.
October 18	7.03	509.9	W. W. Schlecht.
August 28	7.15	644.6	A. E. Place.
August 8	7.50	745.4	Do.
September 4	7.55	836.1	Do.
December 21	7.60	772.0	W. W. Schlecht.[a]
September 3	7.80	1,200.0	A. E. Place.
December 12	8.00	1,490.8	W. W. Schlecht.
November 26	7.21	675.4	Do.
December 30	11.95	5,353.0	Do.[a]

[a] Stream somewhat obstructed by shore ice.

Daily gage height, in feet, of Rondout Creek at Rosendale for 1901.

Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	7.57	7.62	7.26	6.50	6.55	17	6.30	6.50	6.67	7.10	6.55	8.95
2	.....	5.50	7.95	6.85	6.50	6.40	18	6.85	6.75	7.05	7.00	6.55	8.40
3	.....	6.30	7.80	6.95	6.50	6.50	19	6.55	7.30	6.85	6.90	6.55	7.77
4	.....	6.25	7.61	6.80	6.45	6.85	20	6.48	6.95	6.65	6.80	6.50	7.55
5	.....	6.17	7.42	6.70	6.40	6.87	21	6.47	8.75	6.55	6.72	6.40	7.55
6	.....	6.35	6.97	6.62	6.40	6.85	22	6.37	8.15	6.52	6.70	6.35	7.57
7	.....	9.75	6.87	6.55	6.40	6.92	23	6.40	7.50	6.47	6.70	6.40	7.95
8	6.50	7.35	6.77	6.55	6.40	7.00	24	6.35	9.00	6.42	6.60	6.50	7.75
9	6.40	6.92	6.67	6.52	6.40	7.20	25	6.35	9.40	6.40	6.60	7.60	7.22
10	6.25	6.62	6.60	6.45	6.40	9.20	26	6.30	8.10	6.35	6.60	7.25	7.12
11	6.20	7.17	6.60	6.42	6.37	9.25	27	6.47	7.47	6.32	6.60	6.97	7.00
12	6.25	7.42	6.65	6.42	6.45	8.22	28	6.42	7.15	6.30	6.65	6.87	7.35
13	6.30	6.87	6.72	6.50	6.95	7.75	29	6.37	6.95	7.05	6.50	6.80	9.10
14	6.33	6.55	6.57	7.25	6.80	8.97	30	6.67	7.42	7.41	6.50	6.80	12.12
15	6.30	6.50	6.50	7.72	6.62	16.75	31	6.72	6.72	.....	6.50	.....	10.00
16	6.38	6.52	6.62	7.37	6.60	10.60							

DIVERSION FROM RONDOUT CREEK TO FEED DELAWARE AND HUDSON CANAL.

The Delaware and Hudson Canal utilizes slackwater from the mouth of Rondout Creek to Eddyville. From the head of the pond above Eddyville dam the canal runs parallel to Rondout River as far as Napanock. From Napanock to Summitville it follows the valley of Sandberg Creek, tributary to Rondout River at Napanock. Numerous dams on Sandberg Creek, also dams on Rondout Creek at Port Hickson and High Falls, formerly supplied the canal with water from its Summitville level to Hudson River tide water. The Delaware and

Hudson Canal was originally constructed in 1850. In 1898 it was abandoned from Honesdale, Pa., to Ellenville, N. Y. August 1, 1901, the remaining canal, with the exception of that from High Falls feeder to Rondout, was abandoned. The gaging station on Rondout Creek at Rosendale is situated opposite the canal level between locks 6 and 7. The water supply is entirely drawn from the dam and feeder on Rondout Creek below High Falls. A current-meter measurement of the flow in the feeder September 19, 1901, showed the diversion from Rondout Creek to be 28 second-feet at the dam. A measurement of the outflow from the Rosendale level showed the flow in the canal past the gaging station to be 10 second-feet, the remainder of the diverted water having been returned over three intervening wasteweirs.

The presence of the canal parallel with the river probably increases the loss from surface evaporation on Rondout Creek to some extent. The canal follows the left-hand bank of Rondout Creek and intercepts some inflow from drainage on that side. All water diverted from Rondout Creek at High Falls feeder, with the exception of evaporation losses, is returned to the stream before it reaches Rondout. A part of this water is carried past the gaging station at Rosendale. In order to determine the amount of this diversion during the season of canal navigation, usually from April 1 to December 10, a record has been kept at lock 6 or Creek Locks at the lower end of the Rosendale level. The record includes:

(1) Overflow of by-pass weir.
(2) Water used for lockage.
(3) Flow through paddles in miter gates.

There is also a small amount of leakage of the lock wall and gates which has not been estimated. The flow in the canal at lock 6, added to the flow at the Rosendale gaging station, will give the total actual run-off from Rondout Creek watershed above Rosendale. A record at lock 6 has been kept since October 1, 1901, showing the mean monthly diversion as follows:

	Second-feet.
October, 1901	20
November, 1901	19

RONDOUT CREEK AT HONK FALLS, ULSTER COUNTY, N. Y.

Rondout Creek above its junction with Sandberg Creek at Napanock (also called Lackawack Creek) is essentially a mountain stream. At Honk Falls a natural declivity affords a fall of 125 feet over tilted strata of Hudson River shale. This fall has been increased to 147.5 feet by the construction of a masonry dam at the head of the gorge.

Water to feed the turbines is carried to the power house, one-fourth mile below the dam, in a circular steel penstock. The turbines are a special design of the Victor type. The outflow from the turbines passes over a tailrace weir below the power house. The total flow of

the stream passes either over the spillway of the dam or over the tailrace weir. The dam is of concrete masonry. It has an ogee-shaped cross section and a level spillway 186.6 feet in length.

Arrangements have been made for maintaining a record at this plant. A Bristol recording gage will be placed above the dam, arranged to keep a continuous record of the discharge over the dam. A record of the amount of water used by the turbines will also be kept. The maximum observed discharge of Rondout Creek at Honk Falls has been 8,650 second-feet or 98.1 second-feet per square mile from the tributary drainage area of 88 square miles.

The power is used for the generation of electricity, which is transmitted to Ellensville, a distance of 3 miles.

Principal developed water powers on Rondout Creek in 1901.

No. of dam.	Location.	Name of mill and of owner or operator.	Business or class of manufacture.	Working head on water wheels.			Water privilege at dam.	Rated power of water wheels at usual head (horsepower).	Horsepower of engines.
				Greatest.	Least.	Average.			
				Ft.	*Ft.*	*Ft.*			
1	Eddyville	Delaware and Hudson Canal Co.	Slack-water navigation.				Entire	None.	None.
2	Lawrenceville	Lawrenceville Cement Co.	Natural cement			10	do	([a])	
3	Below High Falls	W. I. Vandemark (J. H. Vandemark estate).	do	14	10			[b] 80	125
4	High Falls	Hasbrook & Hopper, Ulster County Savings Bank.	Flour mill			12	Entire		
5	do		Abandoned			31	do		
6	Port Hickory	Delaware and Hudson Canal Co.	Canal Feeder [c]			10	do		
7	Napanock [d]	E. C. Shook & Son	Flour mill			6	do	60	None.
8	Napanock	M. M. Pillsbury	Grind shop			7	do		
9	Napanock (R. H.)	Humphrey & Youngs.	Paper mill			30	One-half	481	
10	Napanock (L. H.)	J. C. & S. E. D. Hornbeck.	do			30	do		
11	Napanock	Pillsbury Ax Factory.							
12	Napanock (L. H.)	Napanock Knife Co.				15½		12	None.
13	do						([c])		
14	Napanock (R. H.)	Young & Humphrey (John Russell estate).	Barking-knife works.				One-half		
15	Napanock (L. H.)	M. M. Pillsbury Paper Mill.	Toilet tissue paper.			56	do	593	
16	Napanock	Honk Falls Power Co.	Generation of electricity.			147½	Entire	1,500	None.
17	Lackawack	C. N. Morse	Excelsior	11		10	do	140	None.
18	Grahamville		Sawmill						
19	Bull River		2 sawmills					50-100	

[a] Power not used.
[b] Dam also feeds Delaware and Hudson Canal.
[c] Abandoned.
[d] Upper Rondout or Lackawack Creek.
[e] Abandoned privilege.

WALLKILL RIVER AT NEW PALTZ, ULSTER COUNTY, N. Y.

Wallkill or New Paltz River has its source in Sparta Mountain, New Jersey, about 21 miles from the point where it enters New York State.[a] From its source to the head of the Drowned Lands it is essentially a highland stream. Mr. Vermeule states that high-water marks on Clove River, one of the tributaries of Wallkill River in this region, indicate a discharge of 67 second-feet from a drainage area of 0.7 square mile, or at the rate of 96 second-feet per square mile.

The Drowned Lands are an extensive Pleistocene lake bottom situated mainly in New York. They comprise an area of 28 square miles. A dam of drift at the north end of this tract holds back the waters of the Wallkill, causing an overflowing of this entire flood plain. Until about fifty-five years ago this area formed a shallow lake or undrained swamp. An artificial canal cut through the drift at the foot has enabled a large part of the downstream portion to be reclaimed for agricultural purposes.

Below the foot of the Drowned Lands, 15 miles from the New Jersey line, the Wallkill flows in a broad, shallow valley, averaging perhaps one-half mile in width. This valley has been eroded from the drift, leaving a stream bed of cobbles and small bowlders too heavy for stream transport. The river terraces are not abrupt, often curving gracefully to the uplands 30 to 60 feet above the stream and leaving a narrow flood plain submerged only during freshets. At frequent intervals the stream cuts through the overlying drift to the Hudson River slate, and passing over ledges of this slate produces waterfalls.[b]

Much of the fall of the stream is concentrated in a number of such cascades having natural declivities, as follows:

Height of cascades on Wallkill River.

Location.	Approximate fall.
	Feet.
Montgomery	9
Walden	26
Wallkill	10
Dashville	42
Rifton Glen	57

The draining of the Drowned Lands is believed to have affected the summer flow of the stream in some degree.

At Gardiner the Wallkill receives its principal tributary, the Shawangunk Kill. The divide between the two streams is formed by vertical strata of blue shale, making a very definite ridge between the drainage basins.

[a] The Wallkill in New Jersey is described in Report of Geological Survey of New Jersey 1894, vol. 3, Water-Supply, by C. C. Vermeule, pp. 147–150. See also The Wallkill, Appendix No. 14, pp. 516–530, Report on New York's Water Supply, by John R. Freeman.

[b] The Geology of Orange County, N. Y., by Heinrich Ries. New York State Museum Report, 1895, part 2, pp. 395–475.

The gaging station is situated in a drift-filled valley at New Paltz highway bridge. The station was established July 7, 1901. Readings of the river stage have been taken twice daily since that date by the observer, E. Tremper. The gage consists of a 15-foot boxed scale graduated decimally, attached horizontally to the tie rods on the downstream side, near the left-hand end of the bridge. The bridge has a span of 146.6 feet between the vertical faces of the masonry abutments. The entire flow passes under this bridge except during extreme freshets, when a flood plain on the left-hand bank is overflowed. At such times discharge measurements can be made at the Wallkill Valley Railroad bridge, 3 miles downstream, where the entire flow is confined to the stream channel at all stages.

The bench mark is a circular chisel draft in the coping on the capstone forming the bridge seat on the right-hand abutment.

Elevation bench mark	100.00
Elevation water service when gage reads zero	70.96

Current-meter measurements of Wallkill River at New Paltz, N. Y.

Date.	Gage height.	Discharge.	Hydrographer.
1901.	*Feet.*	*Second-feet.*	
November 9	5.94	178	W. W. Schlecht.
July 23	5.20	306	A. E. Place.
October 11	6.30	340	W. W. Schlecht.
Do	6.30	355	George B. Hollister.
October 24	6.33	333	W. W. Schlecht.
October 9	6.48	398	Do.
November 16	6.50	402	Do.
July 7	7.19	824	Horton and Hollister.
July 8	7.25	842	Do.
October 1	7.36	896	W. W. Schlecht.
November 27	7.52	1,022	Do.
September 19	7.73	1,076	Horton, Place, and Schlecht.
August 13	7.85	1,038	A. E. Place.
July 19	8.23	1,243	Do.
September 5	8.90	1,676	Do.
August 31	9.07	1,917	Do.
August 20	10.00	2,729	Hollister and Place.
August 28	10.60	2,982	A. E. Place.
December 11	11.50	3,040	W. W. Schlecht.[a]
December 19	13.70	3,277	Do.[a]
August 7	14.85	7,365	A. E. Place.

[a] Stream obstructed by ice causing backwater. December 30, 1901, the river attained a maximum stage of 20.5 feet.

Daily gage height, in feet, of Wallkill River at New Paltz for 1901.

Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1		6.1	9.2	7.45	6.0	6.25	17	6.37	6.75	7.05	7.5	6.25	13.1
2		5.9	9.85	7.25	6.0	6.05	18	7.15	9.25	7.62½	7.27	6.05	13.65
3		5.97	9.75	7.15	6.0	6.0	19	7.98	11.15	7.65	7.15	6.15	13.75
4		6.0	9.35	7.00	6.0	6.2	20	7.2	10.15	7.45	6.95	6.35	12.95
5		6.45	8.55	6.95	6.05	6.35	21	6.5	10.25	7.3	6.7	7.3	11.7
6		6.45	8.35	6.85	6.1	6.65	22	6.35	10.25	7.1	6.45	8.1	10.7
7	7.275	12.05	8.05	6.65	6.0	6.6	23	6.25	10.15	6.95	6.32	8.65	10.45
8	7.23	11.25	7.7	6.47	5.95	7.3	24	6.05	9.7	6.82½	6.3	8.35	10.15
9	6.93	9.3	7.47½	6.35	5.85	10.0	25	6.0	14.3	6.65	6.2	8.10	9.55
10	6.65	9.15	7.45	6.3	5.75	12.3	26	6.0	12.0	6.5	6.12	7.45	9.0
11	6.53	9.1	7.25	6.3	5.65	11.7	27	5.85	11.25	6.35	6.1	6.95	9.25
12	7.33	8.05	7.05	6.2	5.95	10.3	28	5.85	10.6	6.35	6.1	6.85	9.7
13	7.6	7.7	7.15	6.2	6.4	10.05	29	5.85	10.1	6.65	6.1	6.65	11.8
14	7.15	7.15	6.95	6.35	7.0	10.6	30	5.8	9.9	7.25	6.1	6.45	19.35
15	6.85	7.4	6.65	7.5	6.9	13.3	31	5.95	9.15		6.5		19.2
16	6.55	7.1	6.75	7.85	6.55	12.85							

Mean daily flow,[a] in second-feet, of Wallkill River at New Paltz, N. Y., for 1901.

[Drainage area, 736 square miles.]

Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1		264	1,940	886	220	330	18	742	1,975	974	802	242	5,968
2		190	2,423	790	220	242	19	1,159	3,502	988	742	286	6,080
3		212	2,345	742	220	220	20	766	2,622	886	647	374	5,219
4		220	2,045	670	220	308	21	440	2,745	814	532	814	3,998
5		418	1,503	647	242	374	22	374	2,745	718	418	1,230	4,118
6		418	1,280	601	264	509	23	330	2,663	647	363	1,569	2,909
7	801	4,328	1,200	509	220	486	24	242	2,306	589	352	1,380	2,663
8	780	3,590	1,014	429	205	815	25	220	6,714	509	308	1,230	2,189
9	638	2,010	898	374	175	2,540	26	220	4,280	440	275	1,380	1,800
10	509	1,905	886	352	145	4,568	27	175	3,590	374	264	647	1,975
11	453	1,870	790	352	115	3,998	28	175	3,034	374	264	601	2,306
12	828	1,200	694	308	205	2,786	29	175	2,622	509	264	509	4,092
13	962	1,014	742	308	396	2,540	30	160	2,462	790	264	418	([b])
14	742	742	647	374	670	3,034	31	215	1,905		440		([b])
15	1,032	862	509	910	624	5,588							
16	463	718	555	1,092	463	5,117	Mean	521	2,077	963	522	520	2,832
17	382	555	694	910	330	5,376							

[a] These figures are subject to slight changes as more measurements are made.
[b] Exceeds limit of rating table.

Drainage areas of Wallkill River.

Location.	Area.
	Sq. miles.
Wallkill River above Franklin Furnace, N. J	31
Wallkill River at New York and New Jersey State line	210
Wallkill River above foot of Drowned Lands	393
Wallkill River above Freeman's proposed dam site	464
Wallkill River, mouth Shawangunk Kill	563
Shawangunk Kill River above mouth	149
Wallkill River below mouth Shawangunk Kill	712
Wallkill River above gaging station at New Paltz	735
Wallkill River above Rifton Glen	761
Wallkill River Junction with Rondout Creek	779
Wallkill River total drainage in New York	569

A current-meter measurement of the discharge of Wallkill River at Rockford Bridge, New York, was made on August 13, 1900, by E. G. Paul, showing a discharge of 70 second-feet.

Throughout its course the Wallkill flows northeasterly, nearly parallel to Hudson River. It joins Rondout River near Lefever Falls,

and the two enter Hudson River at Rondout. Together they form the most extensive river system in southeastern New York, aside from the Hudson River.

Mean monthly run-off of Wallkill River at New Paltz, N. Y.

[Drainage area, 736 square miles.]

Month.	Discharge.	Discharge per square mile.	Drainage area.
1901.	*Second-feet.*	*Second-feet.*	*Inches.*
July	521	0.71	0.82
August	2,077	2.83	3.25
September	963	1.31	1.47
October	522	.71	.82
November	520	.71	.79
December	2,832	3.85	4.44

Principal developed water powers on Wallkill River in 1901.

No. of dams.	Location.	Name of mill and of owner or operator.	Business or class of manufacture.	Working head on water wheels. Greatest.	Working head on water wheels. Least.	Working head on water wheels. Average.	Water privilege at dam.	Rated power of water wheels at usual head (horsepower).	Horsepower of engines.
				Ft.	*Ft.*	*Ft.*			
1	Creek locks	Empire powder mill, Laflin and Rand Powder Co.	Black blasting powder.	19	9	14	Entire	288	100
2	Rifton	Rifton gristmill, J. W. Dimick, jr.	Gristmill			16		119	
3	do	J. M. Dimick Co	Velvet carpets and Wilton rugs.	32	21		Entire	679	
4	Dashville		Abandoned gristmill [a].	42					
5	Galeville		Abandoned gristmill.			10			
6	Wallkill	J. C. Hedden	Hat factory	14			Entire		
7	Waldon	Waldon Knife Co.	Pocket cutlery	12	11	8	432 square inches.	150	75
8	do	New York Knife Works.	Cutlery	33	31½	32		300	None.
9	Montgomery	Crabtree & Patchett.	Worsted yarns			9	Entire	160	75
10	Red Mills	Red mill [b]	Gristmill			10	do		None.

[a] Abandoned about 1845.

[b] On Shawangunk kill.

FISHKILL CREEK AT GLENHAM, DUTCHESS COUNTY, N. Y.

The headwaters of Fishkill Creek drain the western slope of Chestnut Ridge Mountains. In its upper reaches the stream receives the drainage from extensive swamp and flat lands. The lower reaches of the stream flow along the foot of the Fishkill Range. From Fishkill village to Fishkill Landing, where it empties into tide water of Hudson River, it falls over slate ledges, making a descent of 200 feet in 5 miles. This fall is largely utilized to provide water power for manufactories on its banks. As a result, the stream becomes greatly

polluted from manufacturing waste and other impurities which it receives. The extent and character of the manufactures are shown in the table on page 76.[a]

The gaging station is situated at the Newburg, Dutchess and Connecticut Railroad bridge in Glenham. It was established July 8, 1901. A boxed weight gage, with scale graduated decimally from zero to 15 feet, was attached to the upstream guard rail of the bridge. The water height is observed each morning and evening by the gage reader, C. E. Carey. The bridge consists of a main central span, with two auxiliary overflow channels at the ends, the length of span being as follows:

Left-hand overflow, station 0 to 22.5.
Main span, station 27.5 to station 122.
Right-hand overflow, station 127 to station 149.

The bed of the main channel is earth and gravel; that of the overflow channels is of loose broken stone. The bench mark is an "0" chiseled in the upstream corner of the left-hand pier of the main bridge span.

Elevation of bench mark	100.00
Elevation of water surface when gage reads zero	82.22

The location of the gaging station is shown on the Poughkeepsie sheet of the Topographic Atlas of the United States Geological Survey.

Current-meter measurements of Fishkill Creek at Glenham, N. Y.

Date.	Gage height.	Discharge.	Hydrographer.
1901.	*Feet.*	*Second-feet.*	
July 24	3.60	60	A. E. Place.
October 12	3.80	97	G. B. Hollister.
November 11	3.85	82	W. W. Schlecht.
August 15	3.85	110	A. E. Place.
September 27	3.86	90	W. W. Schlecht.
July 20	3.90	135	A. E. Place.
July 8	3.92	147	Horton and Hollister.
November 20	3.95	114	W. W. Schlecht.
October 5	3.98	126	Do.
October 15	4.05	137	Do.
September 6	4.15	193	A. E. Place.
September 18	4.22	229	Do.
December 24	4.52	315	W. W. Schlecht.
August 21	4.56	342	A. E. Place.
August 30	4.60	335	Do.
December 13	4.62	375	W. W. Schlecht.
October 15	5.10	579	Do.
December 31	7.43	2,210	Do.[b]

[a] For effect on streams of waste from above classes of manufacture see Sewage Disposal in the United States, Rafter and Baker, pp. 32-72.

[b] Surface velocity used.

A measurement through ice 0.3 to 0.4 foot thick was made by W. W. Schlecht December 7, 1901. Gage height, 4.25. Discharge, 100.7 second-feet.

A mark is painted on the right-hand overflow abutment, labeled "High-water mark, January 22, 1891." The elevation of this mark was found to be 96.15, equivalent to a gage reading of 13.93 feet, and this is said to be the highest water on record in the stream. The drainage area above the gaging station is 198 square miles, and above the mouth of the stream 204 square miles.

Daily gage height, in feet, of Fishkill Creek at Glenham, N. Y., for 1901.

Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Day.	July.	Aug.	Sept.	Oct.	Nov	Dec.
1	.....	3.95	4.57	4.05	3.79	3.90	17	3.73	3.85	4.15	4.55	3.95	6.18
2	.....	3.82	4.60	3.97	3.95	3.98	18	4.23	5.07	4.22	4.40	3.95	5.53
3	.....	3.77	4.47	4.10	3.95	4.05	19	4.00	4.70	4.12	4.32	3.95	5.15
4	.....	3.67	4.42	4.10	3.95	4.08	20	3.90	4.40	4.02	4.22	3.95	4.98
5	.....	3.65	4.30	4.00	3.90	4.10	21	3.77	4.45	4.02	4.20	3.93	4.78
6	.....	3.65	4.15	3.92	3.90	4.25	22	3.70	4.95	4.00	4.15	3.93	4.73
7	.....	4.70	4.17	3.90	3.92	4.28	23	3.65	4.62	3.92	4.12	3.90	4.73
8	3.90	5.55	4.10	3.87	3.95	4.18	24	3.65	4.70	3.90	4.10	3.90	4.55
9	3.90	4.77	4.07	3.85	3.90	4.05	25	3.65	6.40	3.87	4.05	4.35	4.60
10	3.80	4.35	4.02	3.85	3.87	4.73	26	3.62	6.55	3.85	4.00	4.33	4.55
11	3.78	4.12	4.05	3.85	3.87	5.33	27	3.60	5.65	3.80	4.00	4.13	4.85
12	3.83	4.07	4.37	3.80	3.92	4.83	28	3.45	5.20	3.87	4.00	4.03	4.15
13	3.80	4.02	4.32	3.80	4.32	4.60	29	3.57	4.85	3.95	4.00	4.00	5.75
14	3.73	3.90	4.15	4.30	4.17	4.68	30	3.35	4.70	4.20	4.00	3.98	8.28
15	3.70	3.90	4.10	4.85	4.05	6.78	31	4.15	4.57	.....	3.97	.....	7.50
16	3.65	3.82	4.25	4.82	4.00	7.45							

Principal developed water powers on Fishkill Creek in 1901.

No. of dam.	Location.	Name of mill and of owner or operator.	Business or class of manufacture.	Working head on water wheels. Greatest.	Least.	Average.	Water privilege at dam.	Rated power of water wheels at usual head (horsepower).	Horsepower of engines.
				Ft.	*Ft.*	*Ft.*			
1	Fishkill	Tironda Hat Works.	Hats	...	...	...	Entire	...	...
2	....do	New York Rubber Co.	Rubber goods	24	...	17	....do	430	250
3	....do	Rockwell Silk Mills	Silk goods	...	...	...	....do	...	...
4	Matteawan	Matteawan Mfg. Co.	Felt hats and bodies.	31	20	26	Part	168	225
5	....do	Wm. Carroll & Co.	Straw hats	...	...	29	....do	283	140
6	....do	Carroll Electric Co.	Electric lighting and power.	...	...	20	Entire	...	525
7	Glenham	Glenham Carpet Mill (Hilton estate).[a]	Carpets, rugs, and squares.	35	30	32½	....do	460	1,500

[a] Not operated.

CROTON RIVER AT OLD CROTON DAM, WESTCHESTER COUNTY, N. Y.

Croton River drains an area of rough, irregular topography, interspersed with lakes and ponds, situated east of Hudson River, to which the stream is tributary at Croton Landing. This stream serves as the principal source of water supply for New York City.[a] The flow is

[a] See History of Water Supply of New York, 1658-1895, by Edward Wedgman.

diverted through a closed masonry aqueduct at what is called the "Old Croton" dam, to distinguish it from the new Croton dam, also called the "Cornell" or "Quaker Bridge" dam, now under construction.[a] The location of the Old Croton dam and of the adjacent watershed is shown on the Carmel and Tarrytown sheets of the topographic atlas of the United States Geological Survey. A record has been kept of the flow of Croton River at the Old Croton dam, beginning in 1868. The record includes the quantity of water wasted over the crest of the dam, as well as that diverted for the water supply of New York City. The results of this record, as originally computed, have been widely published.[b]

In the report on New York's water supply, made to Bird S. Coler, comptroller, by John R. Freeman, 1900, Appendix No. 1 (pages 120–256, inclusive), is devoted to a study of the yield of the Croton watershed. Mr. Freeman states that the results, as heretofore published, average about 10 per cent, or 38,000,000 gallons per day, too large, because of the use of data which were less accurate than those now possessed. Using this later information, he has recomputed the entire record. Owing to the importance of this record, its great length, relative accuracy, and availability for comparison with other streams proposed as sources of water supply for Greater New York, it has been thought well to republish the revised figures, which are given below. In computing the record Mr. Freeman has made the following changes in the methods of calculation:

(1) Revision of the formula for flow over the dam by experiments on model sections at Cornell University hydraulic laboratory. In the calculation of the record as hitherto published the flow over the dam has been calculated, using a constant coefficient in the weir formula of 3.4, based on the experiments of Eytelwein.

(2) Gagings of flow in the Croton aqueduct have been made and the results used as a basis of calculation of the diversion.

(3) The impairment of the carrying capacity of the aqueduct, due to the gradual accumulation of slime or organic growths upon the walls of the conduit, has been taken into consideration.

(4) The effect of storage in the natural and artificial reservoirs in the headwaters of the stream has been allowed for in the calculation, so that the results as given below represent the estimated natural run-off of the watershed.

(5) Errors in the assumed elevation of the crest and length of the overfall of the Croton dam and in the observed depth on the crest of the dam and depth in the Croton aqueduct have been corrected in making the revised calculations.

The depth on the crest of the dam has been determined by measur-

[a] The new Croton dam is described in a paper by Charles S. Gowen in Trans. Am. Soc. Civ. Eng., Vol. XLIII, pp. 469-565.

[b] See Twentieth Ann. Rept. U. S. Geol. Survey, Pt. IV., pp. 81-84; also Report of New York Aqueduct Commission, 1887-1895, pp. 91-101.

ing the distance down to the water surface from the corner of the coping stone of the wing wall on the east bank of the stream at a point just downstream from the intake of the old aqueduct and about 120 feet upstream from the crest. The measurement has been taken at 5 o'clock each morning, and as there are no notable mills on the stream one measurement a day undoubtedly gives a reliable record of the mean wastage. The dam consists of two portions, having different cross sections. Both sections are built of cut stone, with gravel and riprap or concrete backing, and rest on rock foundations.

The longer or round-crested portion is 180.3 feet in length. The crest lip has an elevation varying from 166.170 to 166.299 feet. The crest is ogee shape, the upper portion having a radius of 10 feet, the slope of the upstream side being approximately 6.5 horizontal to 1 vertical. The angular-crested portion of the dam is 71.1 feet in length, its elevation varying from 166.175 to 166.915 feet. The elevation of the point of measuring the depth on the crest is 172.210 feet, and the mean elevation of the crest is 5.975 feet lower. The angular-crested portion of the dam has a crest 7 feet in width, sloping backward 1 vertical to 7 horizontal, and an apron having a slope of 5 horizontal to 4 vertical.

Regarding the accuracy of the record as recomputed, Mr. Freeman states that there are probably very few months in the record for which the error is as great as 5 per cent, and believes it probable that the error in the mean run-off for any year rarely, if ever, exceeds 3 per cent. Whatever uncertainty there is comes mainly from lack of precision in measurement of depth wasting over dam, and from uncertainty as to the condition of interior surface of the two aqueducts, or obstruction therein.

With reference to the effect of storage, the following table is given by Mr. Freeman, showing the total capacity in millions of gallons to crest level of the different reservoirs within the watershed:

Storage reservoirs in Croton River drainage area.

Reservoir.	Date when first filled and available.	Approximate area of tributary watershed.	Area of water surface of storage reservoir.	Aggregate area of water surface in watershed of reservoir.	Approximate area of swamp surface in watershed.	Net area of land surface.	Per cent of water surface to land surface.	Total capacity of reservoir to level of spillway crest (million of gallons).
		Sq. m.	*Sq. m.*	*Sq. m.*	*Sq. m.*	*Sq. m.*		
Boyds Corner, Carmel	1873	21.43	0.463	0.675	0.0	20.75	3.25	2.727
West Branch	1895	19.51	1.560	2.304	.3	17.21	13.40	10.070
Middle Branch	1878	20.51	.672	.766	.7	19.74	3.88	4.005
East Branch Bog Brook and Sedum	1891	76.90	.640 .898	2.125	5.0	74.78	2.84	4.145 4.883
Titicus	1893	22.80	1.103	1.300	.5	21.50	6.04	7.167
Amawalk	1897	18.32	.940	2.132	.05	16.19	13.20	76.78
Old Croton	1842	159.3	.760	1.938	.7	157.4	1.23	.....

The total drainage area above Old Croton dam is 338.8 square miles.

In addition to the above artificial reservoirs, the following ponds are controlled by the city: Mahopac, Kirk, Gleneida, Gilead, Barrett, and White. These have an aggregate capacity above present level of spillway crests of 2,055,000 gallons.

The following ponds are not controlled by the city, but were drawn upon in the great drought in 1881: Peach, Waccabuc, Cross, China, Pine, Long, Tonetta, and Haines. They have an aggregate capacity of 855,000,000 gallons.

In the above estimate of the natural run-off of Croton watershed no allowance has been made for the increased loss by evaporation due to the larger proportion of water surface than would have existed in absence of the artificial reservoirs. The area of water surface exposed to evaporation for different periods during the continuation of the record has been as follows:

Water surface exposed to evaporation in Croton Basin.

Date.	Area.	Per cent of basin.
	Sq. miles.	
1868 to 1873	5.8	1.73
1873 to October, 1878	6.2	1.83
1878 to 1891	6.9	2.03
1891 to 1893	8.4	2.48
1893 to 1895	9.5	2.82
1895 to 1897	11	3.28
1897 to 1900	12	3.56

In estimating the relation of rainfall to run-off on this watershed the mean monthly rainfall, as given in the following table, has been used by Mr. Freeman. This table is made up from rain-gage records kept at the following places:

1870 to 1876, Boyds Corners.
1877, average of Boyds and Croton records.
1878 to 1881, average of Boyds, Croton, and Middle Branch records.
1882 to 1900, average of Boyds, Croton, Middle Branch, and Carmel records.

These rainfall records have been used in estimating the percentage of run-off as hitherto published. The present change in the estimated run-off produces a change in the percentage of rainfall to

run-off, and the values of this percentage, deduced by Mr. Freeman, are given below:

Relation of annual precipitation to run-off on Croton watershed.

[Drainage area, 338.8 square miles.]

Year.	Rainfall.	Run-off.	Difference or evaporation.	Run-off as a percentage of rainfall.	Year.	Rainfall.	Run-off.	Difference or evaporation.	Run-off as a percentage of rainfall.
	Inches.	*Inches.*	*Inches.*			*Inches.*	*Inches.*	*Inches.*	
1868	50.33	33.33	17.00	66.22	1884	51.28	24.08	27.20	46.96
1869	48.36	23.61	24.75	48.82	1885	43.67	17.71	25.96	40.55
1870	44.63	19.20	25.43	43.02	1886	47.74	20.10	27.64	42.10
1871	48.94	19.46	29.48	39.76	1887	57.29	26.61	30.68	46.45
1872	40.74	16.92	23.82	41.53	1888	60.69	35.27	25.42	58.12
1873	43.87	25.02	18.85	57.03	1889	55.70	31.39	24.31	56.36
1874	42.37	25.10	17.27	59.24	1890	54.05	25.95	28.10	48.01
1875	43.66	24.77	18.89	56.73	1891	47.20	23.48	23.72	49.75
1876	40.68	21.09	19.59	51.84	1892	44.28	17.68	26.60	39.93
1877	48.23	20.22	28.01	41.92	1893	54.87	29.05	25.82	52.94
1878	55.70	27.17	28.53	48.78	1894	47.33	20.56	26.77	43.44
1879	47.04	19.65	27.39	41.77	1895	40.58	15.95	24.63	39.31
1880	36.92	12.63	24.29	34.21	1896	45.85	23.26	22.59	50.73
1881	46.69	19.25	27.44	41.23	1897	53.12	25.59	27.53	48.17
1882	52.35	24.28	28.07	46.38	1898	57.40	29.72	27.68	51.77
1883	42.70	13.33	29.37	31.22	1899	44.67	22.28	22.39	49.88

Average flow, in second-feet, of Croton River at old Croton dam.

Month.	1868.	1869.	1870.	1871.	1872.	1873.	1874.	1875.	1876.
January	514	588	1,040	152	537	1,128	2,433	158	373
February	232	574	1,253	644	336	481	801	1,202	1,040
March	1,148	1,462	928	921	452	1,063	783	846	1,869
April	1,029	916	1,214	532	837	1,960	979	1,527	1,703
May	1,567	749	469	531	323	559	829	470	517
June	893	354	218	377	317	142	238	150	181
July	288	158	132	181	155	127	367	145	139
August	541	90	132	221	427	186	227	1,431	130
September	1,485	54	97	164	322	138	153	226	102
October	778	701	111	523	282	368	203	212	101
November	931	563	167	1,012	716	453	184	588	186
December	408	846	156	589	365	786	237	460	172
Year	818	588	493	488	422	616	620	618	543

Month.	1877.	1878.	1879.	1880.	1881.	1882.	1883.	1884.	1885.
January	207	758	362	709	192	614	291	523	115
February	424	1,122	798	817	1,323	128	1,009	1,513	738
March	1,818	1,016	1,120	764	1,589	1,364	763	1,343	534
April	794	444	1,380	551	498	376	736	814	709
May	229	395	492	229	353	603	348	495	408
June	159	388	235	138	455	450	181	178	155
July	130	186	186	138	147	176	132	212	132
August	127	169	368	132	132	132	132	311	149
September	93	633	296	132	132	899	133	193	118
October	271	237	162	130	132	582	170	142	141
November	1,168	557	209	152	124	252	181	265	565
December	506	2,053	495	138	461	334	161	1,030	548
Year	494	663	509	336	462	493	353	585	359

Average flow, in second-feet, of Croton River at old Croton dam—Continued.

Month.	1886.	1887.	1888.	1889.	1890.	1891.	1892.	1893.
January	930	758	1,097	1,204	605	1,903	1,006	503
February	1,429	1,496	1,375	692	9,448	1,757	418	863
March	658	996	1,286	548	1,306	1,170	507	1,723
April	1,289	913	1,399	704	910	681	330	958
May	560	342	718	453	709	249	391	1,621
June	212	320	374	388	416	220	331	283
July	156	710	147	418	229	221	248	251
August	147	951	288	1,115	164	229	241	292
September	132	246	905	627	580	223	266	254
October	132	274	678	506	910	217	232	334
November	234	261	859	1,491	572	189	419	422
December	314	650	1,439	1,253	450	333	441	880
Year	516	660	880	783	1,358	616	403	669

Month.	1894.	1895.	1896.	1897.	1898.	1899.
January	444	795	348	371	1,010	1,075
February	620	309	702	644	1,479	871
March	1,363	907	1,564	828	886	2,051
April	653	1,067	791	681	597	1,119
May	498	351	158	764	1,318	336
June	424	255	311	405	526	351
July	258	255	289	719	320	340
August	249	265	313	826	599	354
September	261	277	300	342	350	348
October	244	254	302	300	391	353
November	659	244	439	308	568	353
December	599	255	309	608	903	351
Year	523	436	485	566	746	659

Run-off, in second-feet per square mile, of Croton River at old Croton dam.

Month.	1868.	1869.	1870.	1871.	1872.	1873.	1874.	1875.	1876.
January	1.52	1.74	3.07	0.447	1.58	3.33	8.19	0.46	1.10
February	.68	1.69	3.70	1.90	.99	1.42	2.37	3.55	3.07
March	3.39	4.32	2.74	2.71	1.33	3.14	2.31	2.49	5.52
April	3.04	2.71	3.59	1.57	2.47	5.79	2.89	4.51	5.03
May	4.64	2.21	1.38	1.56	.96	1.65	2.45	1.39	1.53
June	2.64	1.05	.64	1.12	.94	.42	.70	.44	.53
July	.85	.46	.39	.53	.46	.37	1.08	.43	.41
August	1.59	.26	.39	.65	1.26	.55	.67	4.22	.38
September	.44	.16	.28	.48	.95	.41	.45	.67	.30
October	2.29	2.07	.33	1.54	.83	1.09	.59	.63	.29
November	2.75	1.66	.49	2.98	2.12	1.34	.54	1.74	.55
December	1.21	2.49	.46	1.74	1.08	2.32	.699	1.36	.36
Year	2.45	1.74	1.44	1.43	1.24	1.84	1.83	1.81	1.58

Month.	1877.	1878.	1879.	1880.	1881.	1882.	1883.	1884.	1885.
January	0.61	2.24	1.07	2.09	0.56	1.81	0.86	1.54	3.38
February	1.25	3.31	2.36	2.41	3.91	3.79	2.98	4.77	2.18
March	5.37	3.00	3.31	2.26	4.69	4.03	2.25	3.96	1.57
April	2.34	1.31	4.08	1.63	1.47	1.11	2.17	2.40	2.09
May	.67	1.17	1.45	.67	1.04	1.78	1.03	1.46	1.21
June	.47	1.147	.69	.41	1.34	1.33	.53	.52	.46
July	.38	.55	.55	.41	.43	.52	.41	.63	.39
August	.37	.49	1.08	.38	.41	.41	.41	.92	.44
September	.27	1.87	.87	.39	.41	2.65	.39	.57	.35
October	.79	.69	.48	.38	.41	1.72	.50	.42	.42
November	3.45	1.64	.62	.44	.36	.74	.53	.78	1.67
December	1.49	6.06	1.46	.41	1.36	.98	.47	3.04	1.62
Year	1.46	1.95	1.49	.98	1.35	1.73	1.03	1.72	1.31

Run-off, in second-feet per square mile, of Croton River at old Croton dam—Cont'd.

Month.	1886.	1887.	1888.	1889.	1890.	1891.	1892.	1893.
January	2.75	2.24	3.24	3.55	1.78	5.62	2.97	1.49
February	4.22	4.42	4.06	2.04	2.82	5.19	1.23	2.55
March	1.94	2.94	3.79	1.62	3.86	3.45	1.49	5.09
April	3.81	2.69	4.13	2.08	2.68	2.01	.97	2.83
May	1.65	1.01	2.12	1.34	2.09	.74	1.15	4.79
June	.63	.94	1.11	1.45	1.35	.64	.98	.84
July	.46	2.09	.43	1.23	.66	.65	.73	.74
August	.43	2.81	.85	3.29	.48	.67	.71	.86
September	.39	.72	2.67	1.85	1.71	.66	.78	.75
October	.39	.81	2.00	1.49	2.68	.64	.68	.98
November	.69	.77	2.54	4.41	1.69	.56	1.24	1.25
December	.93	1.92	4.25	3.70	1.33	.98	1.30	2.60
Year	1.50	1.93	2.59	2.32	1.91	1.80	1.19	2.065

Month.	1894.	1895.	1896.	1897.	1898.	1899.
January	1.31	2.35	1.03	1.096	2.98	3.17
February	1.83	.91	2.07	1.90	4.54	2.57
March	4.03	2.63	4.62	2.44	2.62	6.06
April	1.93	3.15	2.34	2.01	1.76	3.30
May	1.47	1.04	.47	2.26	3.89	.99
June	1.25	.75	.92	1.19	1.55	1.03
July	.76	.75	.85	2.13	.95	1.01
August	.74	.78	.92	2.44	1.77	1.05
September	.77	.82	.88	1.01	1.03	1.02
October	.72	.75	.89	.88	1.15	1.04
November	1.95	.72	1.29	.91	1.67	1.04
December	1.77	.75	.91	1.79	2.67	1.03
Year	1.54	1.29	1.47	1.68	2.19	1.94

Average flow of Croton River at old Croton dam.

[Millions of United States gallons per day.]

Month.	1868.	1869.	1870.	1871.	1872.	1873.	1874.	1875.
January	332	380	672	98	347	729	1,573	102
February	150	371	810	416	217	311	518	777
March	742	945	600	595	292	687	506	547
April	665	592	785	344	541	1,267	633	987
May	1,013	484	303	343	209	361	536	304
June	577	229	141	244	205	92	154	97
July	186	102	85	117	100	82	237	94
August	350	58	85	143	276	120	147	925
September	960	35	63	106	208	89	99	146
October	503	453	72	338	182	238	131	137
November	602	364	108	654	463	293	119	380
December	264	547	101	381	236	508	153	297
Year	529	380	319	315	273	400	400	399

Month.	1876.	1877.	1878.	1879.	1880.	1881.	1882.	1883.
January	241	134	490	234	458	124	397	188
February	672	274	725	516	528	835	830	652
March	1,208	1,175	657	724	494	1,027	882	493
April	1,101	513	287	892	356	322	243	476
May	334	148	255	318	148	228	390	225
June	117	103	251	152	89	294	291	117
July	90	84	120	120	89	95	114	85
August	84	82	109	238	85	85	85	85
September	66	60	409	191	85	85	581	86
October	65	175	153	105	84	85	376	110
November	120	755	360	135	98	80	163	117
December	79	327	1,327	320	89	298	216	104
Year	348	319	429	329	217	300	381	228

Average flow of Croton River at old Croton dam—Continued.

Month.	1884.	1885.	1886.	1887.	1888.	1889.	1890.	1891.
January	338	740	601	490	709	778	391	1,230
February	978	477	924	967	889	447	617	1,136
March	868	345	425	644	831	354	844	756
April	526	458	833	590	904	455	588	440
May	320	264	362	221	464	293	458	161
June	115	100	137	207	242	251	269	142
July	137	85	101	459	95	270	144	143
August	201	96	95	615	186	721	106	148
September	125	76	85	159	585	405	375	144
October	92	91	85	177	438	327	588	140
November	171	365	151	169	555	964	370	122
December	666	354	203	420	930	810	291	215
Year	378	288	334	426	569	506	420	398

Month.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.
January	650	325	287	514	225	240	653	695
February	270	558	401	200	454	416	950	563
March	328	1,114	881	586	1,011	535	573	1,326
April	213	619	422	690	511	440	386	723
May	253	1,048	322	227	102	494	352	217
June	214	183	274	165	201	262	340	227
July	160	162	167	165	187	465	207	220
August	156	189	161	171	202	534	387	229
September	172	164	169	179	194	221	226	225
October	150	216	158	164	195	194	253	228
November	271	273	426	158	284	199	367	228
December	285	569	387	165	200	393	584	227
Year	260	452	338	282	314	366	482	426

Total monthly run-off, in inches, of Croton River.

Month.	1868.	1869.	1870.	1871.	1872.	1873.	1874.	1875.	1876.
January	1.75	2.01	3.54	0.51	1.82	3.84	9.44	0.53	1.27
February	.73	1.76	3.85	1.98	1.06	1.48	2.46	3.69	3.31
March	3.91	4.98	3.16	3.12	1.53	3.62	2.66	2.89	6.36
April	3.39	3.02	4.01	1.75	2.75	6.46	3.23	5.03	5.61
May	5.35	2.55	1.59	1.79	1.11	1.90	2.82	1.60	1.76
June	2.95	1.17	.71	1.25	1.05	.47	.78	.49	.59
July	.98	.53	.45	.61	.53	.43	1.24	.49	.47
August	1.83	.30	.45	.75	1.45	.63	.77	4.86	.44
September	.49	.18	.31	.54	1.06	.46	.50	.75	.33
October	2.64	2.38	.38	1.77	.95	1.26	.68	.73	.33
November	3.07	1.85	.55	3.33	2.36	1.49	.60	1.94	.61
December	1.395	2.87	.53	2.01	1.25	2.67	.80	1.57	.42
Total	28.48	23.60	19.53	19.41	16.92	24.71	25.98	24.57	21.50

Month.	1877.	1878.	1879.	1880.	1881.	1882.	1883.	1884.	1885.
January	0.70	2.58	1.23	2.41	0.64	2.08	0.99	1.77	3.89
February	1.30	3.45	.37	2.60	4.07	3.95	3.10	4.82	2.27
March	6.19	3.46	3.82	2.61	5.41	4.65	2.59	4.56	1.81
April	2.61	1.46	4.55	1.82	1.64	1.24	2.42	2.68	2.33
May	1.20	1.35	1.67	.77	1.20	2.05	1.18	1.68	1.39
June	.52	1.27	.77	.46	1.49	1.18	.59	.58	.51
July	.44	.63	.63	.47	.49	.60	.47	.73	.45
August	.43	.56	1.24	.44	.47	.47	.47	1.06	.51
September	.30	2.08	.97	.44	.46	2.95	.44	.64	.39
October	.91	.79	.55	.44	.47	1.98	.57	.48	.48
November	3.85	1.83	.69	.49	.40	.83	.59	.87	1.86
December	1.72	6.98	1.68	.47	1.57	1.13	.54	3.50	1.87
Total	20.17	26.44	18.17	13.42	18.31	23.41	13.95	23.37	17.76

Total monthly run-off, in inches, of Croton River—Continued.

Month.	1886.	1887.	1888.	1889.	1890.	1891.	1892.	1893.
January	3.17	2.58	3.73	4.09	2.05	6.48	3.42	1.72
February	4.39	4.60	4.38	2.12	2.94	5.40	1.33	2.65
March	2.24	3.39	4.37	1.87	4.45	3.97	1.72	5.87
April	4.25	3.00	4.61	2.32	2.99	2.24	1.08	3.16
May	1.90	1.16	2.44	1.54	2.41	.85	1.32	5.52
June	.70	1.05	1.24	1.62	1.51	.71	1.09	.94
July	.53	2.41	.49	1.42	.76	.75	.84	.85
August	.49	3.24	.98	3.79	.55	.77	.82	.99
September	.44	.80	2.98	2.06	1.91	.74	.87	.84
October	.45	.93	2.30	1.72	3.09	.74	.78	1.13
November	.77	.86	2.83	4.92	1.88	.62	1.38	1.39
December	1.07	2.21	4.90	4.26	1.53	1.13	1.50	2.99
Total	20.40	26.23	35.25	31.73	26.07	24.40	16.15	28.05

Month.	1894.	1895.	1896.	1897.	1898.	1899.
January	1.51	2.71	1.18	1.26	3.44	3.65
February	1.90	.95	2.25	1.98	4.52	2.68
March	4.65	3.09	5.33	2.81	3.02	6.98
April	2.15	3.52	2.61	2.24	1.96	3.68
May	1.69	1.20	.54	2.61	4.48	1.14
June	1.39	.83	1.03	1.33	1.73	1.15
July	.88	.86	.98	2.46	1.09	1.16
August	.85	.90	1.06	2.81	2.04	1.21
September	.86	.92	.98	1.13	1.15	1.14
October	.83	.86	1.03	1.01	1.33	1.20
November	2.18	.80	1.44	1.02	1.86	1.16
December	2.04	.86	1.05	2.06	3.08	1.19
Total	20.93	17.50	19.48	22.72	29.70	26.34

Total monthly precipitation, in inches, on Croton River watershed.

Month.	1868.	1869.	1870.	1871.	1872.	1873.	1874.	1875.	1876.
January	2.90	3.79	4.51	3.80	1.44	5.66	6.96	2.74	1.42
February	1.38	3.64	6.40	3.81	1.22	3.09	2.78	3.47	4.91
March	2.55	5.48	3.80	4.27	2.59	3.08	1.57	4.99	6.33
April	3.87	2.11	5.45	3.01	3.04	3.77	6.31	3.04	4.43
May	8.79	4.52	2.30	3.45	3.69	2.91	1.99	1.08	3.99
June	4.53	3.59	2.06	5.73	4.00	.71	3.57	3.02	2.52
July	2.13	2.26	3.43	5.07	4.34	2.21	5.08	3.10	3.42
August	6.98	1.92	5.10	5.24	5.99	5.73	2.75	10.33	1.20
September	9.33	3.20	2.85	1.44	3.69	3.73	3.56	2.11	5.21
October	.87	9.46	4.73	6.18	2.15	5.13	2.40	3.61	1.50
November	4.65	2.43	2.51	4.35	4.01	3.72	2.72	4.61	3.40
December	2.35	5.96	1.49	2.59	3.68	4.13	1.78	1.56	2.35
Year	50.33	48.36	44.63	48.94	40.74	43.87	42.37	43.66	40.68

Month.	1877.	1878.	1879.	1880.	1881.	1882.	1883.	1884.	1885.
January	2.86	4.71	2.79	3.43	4.85	4.68	3.40	4.87	5.41
February	.94	4.06	3.14	3.40	5.25	5.72	5.38	5.52	4.44
March	8.11	3.04	4.57	3.90	6.54	3.99	1.78	3.99	1.26
April	2.47	3.05	4.76	3.57	1.27	1.42	3.42	2.88	2.27
May	.76	4.67	2.29	1.04	4.03	5.92	2.56	3.90	2.09
June	5.16	4.18	5.27	1.40	4.67	2.74	4.52	2.52	1.17
July	5.26	4.05	5.87	5.86	2.48	3.13	4.89	6.31	5.01
August	2.75	3.06	6.95	4.16	2.46	3.16	2.69	6.89	6.71
September	1.36	7.83	3.32	2.42	.78	14.63	2.61	.85	1.10
October	9.15	4.10	.60	2.83	2.95	2.86	6.24	2.92	5.17
November	7.95	4.79	2.95	2.32	5.23	1.61	1.56	4.24	5.96
December	1.46	7.62	4.44	2.59	6.18	2.49	3.65	6.39	3.08
Year	48.23	55.70	47.04	36.92	46.69	52.35	42.70	51.28	43.67

Total monthly precipitation, in inches, on Croton River watershed—Continued.

Month.	1886.	1887.	1888.	1889.	1890.	1891.	1892.	1893.
January	5.42	5.77	5.31	5.05	2.54	9.06	6.18	3.61
February	4.92	6.29	5.02	2.25	4.38	5.71	1.14	7.43
March	3.91	3.72	5.81	1.76	6.09	3.42	3.61	4.25
April	3.84	3.09	2.57	4.45	3.43	3.02	1.08	3.13
May	4.28	.31	6.04	2.96	5.84	1.59	5.56	7.88
June	3.28	6.79	2.24	3.87	3.97	2.13	3.54	2.38
July	5.31	11.23	2.41	9.77	5.07	4.08	5.71	2.88
August	3.09	6.73	6.60	3.73	4.27	5.05	.12	7.13
September	2.29	1.70	10.00	6.42	6.78	1.97	2.25	2.56
October	2.14	3.56	4.69	3.87	6.73	2.32	.93	5.39
November	5.39	2.52	4.07	8.54	1.09	3.49	7.12	3.13
December	3.87	5.58	5.93	3.03	3.86	5.36	1.04	5.10
Year	47.74	57.29	60.69	55.70	54.05	47.20	44.28	54.87

Month.	1894.	1895.	1896.	1897.	1898.	1899.
January	3.22	4.70	1.14	3.49	4.98	3.85
February	4.60	1.86	7.27	2.67	4.51	5.43
March	1.77	2.12	7.71	3.40	2.90	6.63
April	2.83	4.57	1.20	3.01	3.67	1.75
May	5.72	2.11	3.03	6.02	7.77	1.90
June	1.56	2.35	3.89	3.10	1.41	5.62
July	2.68	4.73	4.52	12.49	4.24	5.93
August	3.71	4.11	3.84	5.20	11.52	.64
September	6.70	1.32	5.39	1.82	2.24	7.19
October	5.72	3.64	2.31	1.25	4.83	1.27
November	4.63	4.58	3.57	5.69	6.29	1.91
December	4.19	4.49	1.98	4.98	3.04	2.49
Year	47.33	40.58	45.85	53.12	57.40	44.67

TENMILE RIVER BELOW DOVER PLAINS, DUTCHESS COUNTY, N. Y

This stream is tributary to Housatonic River below Gaylordsville, Conn. A meter station was established September 16, 1901, by A. E. Place, at Tabor's bridge, which crosses Tenmile River about 2,000 feet below the point of inflow of Swamp River. The gaging station is situated about 2 miles below Dover Plains village. Its location may be seen on the Clove sheet of the Topographic Atlas of the United States Geological Survey.

Tabor's bridge consists of a single span 85 feet between abutments. The bridge stands squarely across the stream, the bed of which is sand and gravel. The entire flow passes between the abutments of this bridge except at the time of extreme high water of nearly every spring, when the river overflows its bank and some water passes around one end of the bridge. During extreme low water, measurements may be made by wading a short distance below the inflow of Swamp River. A 13-foot boxed weight and wire gage was attached to footplates bolted to horizontal chords of the bridge in the first panel from the right end of the upstream side. The water stage is observed twice daily, morning and evening, by the gage reader, J. J. O'Brien. The bench mark is an oval chisel draft near the bridge seat of the right-hand truss on the upstream side of the abutment.

	Feet.
Elevation of bench mark	100.00
Elevation of water surface when gage reads zero	83.80

The tributary watershed of Tenmile River lies almost wholly in New York State. The drainage area above the proposed dam site, one-half mile above Webatuk village, is estimated by John R. Freeman at 200 square miles. An area of 5.5 square miles intervenes between this dam site and the gaging station. The drainage area above the gaging station is 195 square miles.

Current-meter discharge measurements of Tenmile River at Tabor's bridge, below Dover Plains, N. Y.

Date.	Gage height.	Discharge.	Hydrographer.
1901.	*Feet.*	*Second-feet.*	
September 16	5.27	245.4	A. E. Place.
September 28	4.36	70.3	W. W. Schlecht.
November 11	4.75	121.5	Do.
November 22	4.76	123.4	Do.
Do	4.76	120.9	Do.
November 6	4.88	140.1	Do.
October 26	5.01	187.6	Do.
December 27	6.54	554.0	Do.
October 15	7.19	692.8	Do.
December 17	8.41	1,213.4	Do.

In addition to the above discharge measurements, a gaging of Swamp River was made by A. E. Place and R. E. Horton just above its mouth September 17, 1901, showing the volume of flow to be 38 second-feet, the gage height being 5.9 feet.

Two measurements of Tenmile River at Webatuk, N. Y., were made by E. G. Paul in 1900, as follows:

	Second-feet.
August 9, discharge	46
October 20, discharge	32

Water is diverted from a small tributary of Tenmile River at the so-called Seven Wells, 1 mile above the gaging station, for the supply of the village of Dover Plains. The amount of diversion is very small.

Daily gage height, in feet, of Tenmile River at Dover Plains, N. Y., for 1901.

Day.	Sept.	Oct.	Nov.	Dec.	Day.	Sept.	Oct.	Nov.	Dec.
1		5.02	4.95	4.65	17	5.00	6.17	5.05	8.15
2		4.80	4.90	4.67	18	5.30	5.87	5.90	7.20
3		5.00	4.90	4.95	19	5.00	5.62	4.88	6.85
4		5.00	4.85	5.50	20	4.85	5.50	4.88	6.35
5		4.88	4.88	6.05	21	4.80	5.48	4.85	5.95
6		4.85	4.88	5.40	22	4.80	5.40	4.80	5.75
7		4.75	4.85	5.02	23	4.70	5.35	4.75	5.92
8		4.65	4.80	4.80	24	4.60	5.27	4.75	5.90
9		4.65	4.77	4.77	25	4.58	5.20	5.20	5.95
10		4.65	4.75	6.35	26	4.50	5.00	5.10	6.40
11		4.65	4.68	6.72	27	4.55	5.02	4.90	6.48
12		4.65	4.98	6.35	28	4.38	5.05	4.95	6.50
13		4.58	5.90	6.12	29	4.78	4.98	4.85	10.70
14		6.28	5.50	6.48	30	5.50	4.95	4.72	12.30
15		6.82	5.28	11.17	31		4.92		10.22
16		6.42	5.10	9.50					

Before the decline in prices of wrought iron, water power for blowing small iron furnaces was utilized at a number of points in the Tenmile River drainage area.

Water privileges on Tenmile River and tributaries.[a]

No.	Description.
1	At State line, abandoned about 25 years ago.
2	At Webatuk sawmill, abandoned about 8 years ago
3	Gristmill at South Dover, 200 square miles watershed, 9 feet average fall, 75 to 100 horsepower.
4	Dover Furnace on Swamp River, abandoned about 40 years ago.
5	Dover Furnace on brook leading into Swamp River, abandoned about 30 years ago.
6	Dover Plains, Winant's dam, rough block-stone and timber-crib construction, 8-foot fall, 134 square miles watershed, affords power to electric-light plant and gristmill, average perhaps 100 horsepower.
7	Steel Works Settlement, Amenia Township, gristmill, abandoned 5 years ago.
8	Singpak, Amenia Township, abandoned 30 years ago.
9	South Amenia, gristmill, 8-foot fall, 80 square miles watershed, 20 or 30 horsepower.

[a] Report on New York's water supply, by John R. Freeman, 1900, page 398.

HOUSATONIC RIVER AT GAYLORDSVILLE, CONN.

Housatonic River rises in Hancock Mountains, northwestern Berkshire County, Mass. In its course to its outlet in Long Island Sound it crosses the western end of Connecticut and nearly the entire width of Massachusetts. It parallels, at a distance of a few miles, the eastern boundary of New York State, extending from Hoosic River watershed nearly to Long Island Sound.

A gaging station was established at Gaylordsville, Conn., by E. G. Paul, October 24, 1900. This station is situated 3 miles east of the New York State line and 2 miles below the mouth of Tenmile River, the principal tributary from New York State. The location of the station may be seen on the New Milford sheet of the Topographic Atlas of the United States Geological Survey.

Daily river-height observations are made by the gage reader, George H. Monroe. The gage scale is 16 feet in length, divided decimally. It is attached to woodwork on the inside of the covered highway bridge, in a horizontal position. The observations are made by means of a weight suspended by a sash chain running over a pulley at the zero end of the gage scale.

Owing to unfavorable conditions underneath the bridge, the discharge measurements are made from a cable of 200-foot span placed across the stream 1¼ miles below the bridge. The cable is supported on the right bank by timber shears 25 feet high, and is anchored to a large buried rock. On the left bank a sycamore tree serves as a support for the cable, which is anchored to the base of a large oak.

The cable station is situated at the site of the proposed storage dam for the water supply of Greater New York. The tributary drainage area above the cable is estimated from the United States Geological Survey maps to be 1,020 square miles.

A number of undeveloped water powers of considerable magnitude exist on Housatonic River in Connecticut. The principal facts regarding these are given by John R. Freeman, as follows:[a]

Undeveloped water powers on Housatonic River.

Location.	Tributary drainage area.	Available fall.	Location.	Tributary drainage area.	Available fall.
	Sq. miles.	*Feet.*		*Sq. miles.*	*Feet.*
Zoar	1,532	50	Bull's bridge	780	30
Little York	1,389	12	Kent Furnace	755	8
Southville	1,219	25	Swift Bridge		15
New Bridge	1,206	20	Cornwall bridge		10
Gaylordsville	998	15			

Current-meter discharge measurements of Housatonic River at Gaylordsville, Conn.

Date.	Gage height.	Discharge.	Hydrographer.
1900.	*Feet.*	*Second-feet.*	
October 20	3.00	303.0	E. G. Paul.
October 24	3.10	370.0	Do.
August 9	3.30	450.0	Do.
August 10	3.25	422.0	Do.
1901.			
March 30	6.20	4,718.0	A. K. Chittenden.
April 27	7.20	7,419.0	Do.
August 3	3.50	549.5	A. E. Place.
September 13	4.00	911.7	Do.
September 28	3.78	700.8	W. W. Schlecht.
October 29	4.05	951.0	Do.
November 13	4.82	1,863.7	Do.
November 23	4.11	965.4	Do.
December 28	5.16	2,520.0	Do.

[a] Descriptions of Housatonic water powers are given by Freeman in his report on New York's water supply, 1900, pp. 398–424; also see the Housatonic River and Its Tributaries, by Dwight Porter, Ph. D., 10th U. S. Census, 1880, vol. 16, Water Power, part 1, pp. 308–324.

Daily gage height, in feet, of Housatonic River at Gaylordsville, Conn., for 1900.

Day.	Oct.	Nov.	Dec.	Day.	Oct.	Nov.	Dec.	Day.	Oct.	Nov.	Dec.
1		3.2	4.9	12		3.7	4.2	23	2.9	3.9	4.8
2		3.1	4.6	13		3.6	4.2	24	3.1	3.9	5.1
3		3.1	4.3	14		3.7	4.2	25	3.2	3.8	4.3
4		2.9	4.2	15		3.7		26	3.1	4.6	4.2
5		3.0	5.6	16		3.7		27	3.1	5.5	4.1
6		2.9	5.8	17		3.6		28	3.1	5.4	4.2
7		2.8	5.4	18		3.5		29	3.1	5.1	4.0
8		3.2	5.1	19		3.6		30	3.0	4.9	3.9
9		3.5	4.9	20		3.7		31			4.2
10		4.1	4.5	21		4.1					
11		3.9	4.2	22		4.0					

Daily gage height, in feet, of Housatonic River at Gaylordsville, Conn., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4.40	3.20	3.30	5.30	6.20	6.20	3.60	3.50	4.30	4.30	4.00	4.00
2	4.00	3.30	3.50	5.30	6.20	6.00	3.50	3.70	4.40	4.20	4.20	4.10
3	[a]	3.30	3.60	5.30	6.40	5.70	3.80	3.50	4.70	4.50	4.00	4.20
4	[a]	3.30	3.60	6.10	6.30	5.50	3.90	3.40	4.60	4.60	3.80	4.10
5	[a]	3.10	4.10	6.60	6.00	5.50	3.70	3.30	4.60	4.40	3.70	4.00
6	4.50	3.00	3.90	6.50	5.60	5.20	4.00	3.30	4.40	4.20	4.10	4.00
7	4.50	3.40	3.90	7.30	5.50	5.20	4.00	3.90	4.40	4.00	3.80	3.90
8	4.40	3.50	3.60	8.30	5.30	5.50	3.80	4.80	4.40	3.90	3.80	3.80
9	4.20	3.40	3.50	8.00	5.20	5.50	3.80	4.40	4.00	4.00	3.80	3.90
10	4.40	3.70	[b] 7.50	7.80	5.20	5.40	3.80	4.10	3.90	4.00	3.70	5.00
11	4.10	3.50	8.20	7.20	5.70	5.20	3.90	4.00	4.00	3.80	3.50	5.50
12	4.70	3.30	7.50	6.70	6.30	4.90	4.00	3.90	4.20	3.80	3.60	5.90
13	4.00	3.40	6.00	6.50	6.10	4.80	4.00	3.70	4.00	3.80	4.80	5.70
14	3.50	3.70	5.50	6.10	6.00	4.60	3.90	3.70	4.00	5.20	4.90	5.80
15	3.70	3.60	5.60	5.90	5.60	5.20	3.60	3.60	4.00	6.70	4.70	8.90
16	2.80	3.40	5.60	5.90	5.50	4.70	3.50	3.70	4.10	6.00	4.60	8.20
17	4.40	3.40	4.60	5.50	5.30	4.50	3.70	3.60	4.10	5.80	4.50	7.80
18	4.00	3.40	4.60	5.30	5.30	4.20	3.60	3.70	4.70	5.30	4.40	7.50
19	3.50	3.20	4.80	5.20	5.80	4.30	3.60	4.00	4.50	5.10	4.22	6.80
20	3.40	3.30	4.80	5.20	6.20	4.20	3.60	3.80	4.40	4.90	4.30	6.10
21	3.80	3.40	10.00	7.25	6.20	4.10	3.60	4.10	4.20	4.80	4.20	5.60
22	3.60	3.50	8.70	9.30	5.80	4.00	3.50	4.70	4.20	4.60	4.20	5.10
23	3.70	3.40	7.40	8.40	5.80	4.30	3.40	4.80	4.00	4.50	4.10	4.90
24	3.50	3.20	7.10	8.50	5.60	4.70	3.60	4.80	3.80	4.40	4.20	5.20
25	3.60	3.30	6.60	8.80	6.80	4.60	3.60	6.80	3.90	4.30	4.60	5.20
26	3.70	3.00	6.60	7.85	6.70	4.30	3.50	6.70	3.80	4.30	4.80	5.00
27	3.80	3.40	7.20	7.20	6.80	4.20	3.50	5.70	3.80	4.20	4.50	5.30
28	3.70	3.30	6.90	6.90	6.80	4.00	3.50	5.20	3.80	4.00	4.00	5.10
29	3.50		6.60	7.00	6.90	4.00	3.50	4.80	3.90	4.00	4.00	6.30
30	3.50		6.20	6.40	6.80	3.80	3.40	4.60	4.40	4.30	4.20	9.40
31	3.40		5.80		6.60		3.70	4.40		4.10		7.60

[a] Frozen. [b] Ice went out.

Estimated low-water flow of Housatonic River at Gaylordsville, Conn., for 1900.

[Drainage area, 1,020 square miles.]

Day.	Oct.	Nov.	Dec.	Day.	Oct.	Nov.	Dec.	Day.	Oct.	Nov.	Dec.
1		395	1,970	12		670	1,075	23		810	1,820
2		355	1,545	13		605	1,075	24	355	810	[a]
3		355	1,180	14		670	1,075	25	395	740	1,180
4		[a]	1,075	15		670	[a]	26	355	1,545	1,075
5		315	[a]	16		670		27	355	[a]	980
6		[a]		17		605		28	355		1,075
7				18		550		29	355		890
8		395		19		605		30	315	1,970	810
9		550	1,970	20		670		31	[a]		1,075
10		980	1,410	21		980					
11		810	1,075	22		890					

[a] Discharge exceeds limit of rating curve.

Estimated low-water flow of Housatonic River at Gaylordsville, Conn., for 1901.

[Drainage area, 1,020 square miles.]

Day.	Jan.	Feb.	Mar.	Apr.[a]	May.[a]	June.[a]	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1,290	395	450	.....	.....	.....	605	550	1,180	1,180	890	([b])
2	1,290	450	550	.....	.....	.....	550	670	1,290	1,075	1,074	.....
3	([b])	450	605	.....	.....	.....	740	550	1,680	1,410	890	.....
4	.....	450	605	.....	.....	.....	810	500	1,545	1,545	740	.....
5	.....	355	980	.....	.....	.....	670	450	1,545	1,290	670	980
6	1,410	315	810	.....	.....	.....	890	450	1,290	1,075	980	890
7	1,410	500	810	.....	.....	.....	890	810	1,290	890	740	810
8	1,290	550	605	.....	.....	.....	740	1,820	1,290	810	740	.....
9	1,290	500	550	.....	.....	.....	740	1,290	890	890	740	.....
10	1,290	670	([a])	.....	.....	.....	740	980	810	890	670	.....
11	890	550	.....	.....	.....	.....	810	890	890	740	550	.....
12	1,680	450	.....	.....	.....	.....	890	810	1,075	740	605	.....
13	890	500	.....	.....	.....	1,820	890	670	890	740	1,820	.....
14	550	670	.....	.....	.....	1,545	810	670	890	([a])	1,970	.....
15	670	605	.....	.....	.....	.....	605	605	890	.....	1,680	.....
16	740	500	.....	.....	.....	1,680	550	670	980	.....	1,545	.....
17	1,290	500	.....	.....	.....	1,410	670	605	980	.....	1,410	.....
18	890	500	.....	.....	.....	1,075	605	670	1,680	.....	1,290	.....
19	550	395	.....	.....	.....	1,180	605	890	1,410	.....	1,075	.....
20	500	450	.....	.....	.....	1,075	605	740	1,290	1,970	1,180	.....
21	740	590	.....	.....	.....	980	605	980	1,075	1,820	1,075	.....
22	605	550	.....	.....	.....	890	550	1,680	1,075	1,545	1,075	.....
23	670	500	.....	.....	.....	1,180	500	1,820	890	1,410	980	.....
24	550	395	.....	.....	.....	1,680	605	1,820	740	1,290	1,075	.....
25	605	450	.....	.....	.....	1,545	605	([a])	810	1,180	1,545	.....
26	670	315	.....	.....	.....	1,180	550	.....	740	1,180	1,820	.....
27	740	500	.....	.....	.....	1,075	550	.....	740	1,075	1,410	.....
28	670	450	.....	.....	.....	890	550	.....	740	890	890	.....
29	550	.....	.....	.....	.....	890	550	1,820	810	890	890	.....
30	550	.....	.....	.....	.....	740	500	1,545	1,290	1,180	1,075	.....
31	500	.....	.....	.....	.....	.....	670	1,290	.....	980	.....	.....

[a] Discharge exceeds limit of rating curve. [b] No record.

MISCELLANEOUS GAGINGS OF HOUSATONIC RIVER.

For comparison with current-meter measurements at Gaylordsville, the following previous measurements of low-water flow of the Housatonic River have been abstracted from the reports from Freeman and Porter, cited above. A series of gagings of Housatonic River at Kent, Conn., extending from July to October, inclusive, 1878, by Horace Loomis, showed a minimum flow of 260 second-feet from 755 square miles of watershed, or 0.34 second-foot per square mile. The mean daily flow from May 22 to November 1, 1878, was 460 second-feet.[a]

In connection with the water power at Birmingham, Conn., the minimum observed flow of Housatonic River is stated by Mr. D. S. Brinsdale, chief engineer of the Housatonic Power Company, to be 500 second-feet from a drainage area of 1,580 square miles, or 0.316 second-foot per square mile.

Occasional gagings during 1881 and 1882 were made by Mr. H. H. Hull, C. E., at New Milford Falls, Conn. His gagings showed the minimum flow during working hours, when pond storage at the various mills was being drawn upon, to be 916 second-feet from 1,088 square miles drainage. The minimum daily flow for twenty-four hours would be less.

[a] Report of Department of Public Works of New York City for quarter ending June 30, 1879.

METHODS EMPLOYED IN GAGING NEW YORK STREAMS.[a]

The following report contains the results of hydrographic work done in the State of New York by the Hydrographic Division of the United States Geological Survey in cooperation with the State of New York, Edward A. Bond, State engineer. The results of investigations in 1900 are also included. In republishing the data presented in the progress report for 1900 corrections in the text have been made and much additional matter given.

At the time the work was undertaken in April, 1900, gaging records were being kept at about twenty stations, most of which had been established in connection with the Upper Hudson storage survey of 1895 and 1896 or by the United States Board of Engineers on Deep Waterways.[b]

These stations were all in connection with dams and mills. The method pursued in gaging the discharge of a stream at a dam may be briefly outlined as follows: Considering first the dam proper, the length and profile of the crest has in each case been determined during the season of low water, and the volume of flow, corresponding to a series of observed depths on the crest, has been computed by the weir formula.

In order to take into account modifications of discharge, due to variations in the width of crest of dams, slope and form of aprons, etc., values of the coefficient C have been selected in each case, as deduced from experiments made at the hydraulic laboratory of Cornell University for the United States Board of Engineers on Deep Waterways; also experiments made by John R. Freeman, C. E., have largely been drawn upon.

In many cases the profiles of the dams are slightly irregular. The dam is divided into sections which are computed separately, all points in a given section being nearly or precisely at the same elevation. For rough calculations of flood flows, etc., the average crest elevation is sometimes taken. This method gives slightly too small results throughout, inasmuch as the discharge over the lower part of the crest is greater in proportion to the head than that over the higher portions of the profile.

Gages have, as a rule, been placed several feet upstream from dams, where the cross-sectional areas of the mill ponds are so great as to make the velocity of approach negligible.

Having calculated the flow for a series of crest depths extending from zero to the extreme high-water mark, a discharge curve has been plotted, from which the volume of flow over the entire dam, corresponding to any gage height, could be read directly. When flash-

[a] From report by R. E. Horton, resident hydrographer.

[b] See reports of George W. Rafter, engineer in charge, contained in Reports of New York State Engineer and Surveyor, 1895 and 1896, and in Report of United States Board of Engineers on Deep Waterways, Part II.

boards are placed on dams the conditions are reduced more nearly to those of a standard sharp-edged weir, and Francis's well-known formula has been used in computing the discharge. The flow over waste weirs, auxiliary spillways, and flood overflows has been calculated in a manner similar to that used for dams. The amount of flow through head gates, sluiceways, feeder gates, and similar openings has been calculated from the formula for orifices. Precise experiments to determine the value of the coefficient of discharge through large submerged orifices, as in bulkheads or canal feeder gates, are greatly needed.

In estimating the discharge through turbine water wheels the results of tests made at the testing flume of the Holyoke Water Power Company have been largely depended upon, the mean discharge for each day having been computed from the observed working head, width of opening of speed gates, and number of hours each wheel has run. A record of these facts is kept at each of the stations where there are mills in connection with dams.

One difficulty encountered in gaging northern streams results from the accumulation of ice during the winter season. It has been found impossible to keep some dams clear of ice, and an effort is made to keep a record of the relative length of the clear and obstructed portions of the dam, from which a correction in the calculated flow can be made.[a]

Views of the cross sections of many of the dams where gaging records are kept, as well as the results of the experiments made at Cornell University to determine the proper coefficients of discharge, may be found in a paper on "Flow of water over dams," by George W. Rafter, M. Am. Soc. C. E., contained in Trans. Am. Soc. C. E., Vol. XLIV, pages 220–398. See also Water-Supply and Irrigation Paper U. S. Geol. Survey No. 35, page 2. In connection with all older stations at dams and mills, an effort has been made to check and improve upon the previous results by making current-meter measurements to determine the volume of flow through turbine water wheels and the proper allowance to be made for leakage of dams, and to check the calculated flow over dams.

In the establishment of stations no single method of gaging has been adopted to the exclusion of all others. The report shows results obtained at dams and mills; by measurements over standard weirs; through thin partitions, and by current meter. In many instances two or more methods have been combined at a single station. Owing to different methods and conditions, the degree of accuracy obtained is not uniform throughout the records. An effort has been made to describe each station with sufficient fullness to enable the reader to clearly understand the methods employed and probable accuracy of the results.

[a] See "Difficulties encountered in gaging streams over dams," by H. A. Pressey: Twenty-first Ann. Rept. U. S. Geol. Survey, Pt. IV, pp. 21–30.

Recent developments in electric transmission have given an impetus to the construction of substantial masonry dams and power plants on many streams, affording almost ideal conditions for maintaining gaging records. Most of the stations at dams are in connection with such plants. Private individuals or corporations interested often cooperate, and excellent records are in this way obtained with comparatively slight expense. At the newer stations where the current-meter method is employed, a modified form of Price meter, adopted by the United States Geological Survey, has been used. This instrument is made in two sizes, the larger for strong currents, the smaller for streams of moderate or low velocity of flow.

The usual mode of procedure is to submerge the current meter 0.6 of the depth of the stream at measured intervals across the channel and record the revolutions for the period of one hundred seconds. In cases of doubt, surface and bottom velocities are also taken or the flow determined by the method of integration as a check. The mean velocity in vertical planes is also measured from time to time to check the accuracy of the 0.6 method and also to determine whether any progressive change is taking place in the measuring section due to sedimentation or scour.

The current meters used are calibrated each year at the rating station of the Geological Survey at Chevy Chase, Md. A rating table for the meter is then prepared, by means of which the velocity of flow of the stream can be deduced from the observed revolutions per second of the meter wheel. Soundings are taken in connection with the meter observations, and a simple multiplication of the velocity in each section by the cross-sectional area to which it applies gives the rate of discharge. A river-height gage is established at each current-meter station from which the stage of the stream is observed once or twice daily. Current-meter measurements of the discharge are made from time to time as opportunity permits. After a sufficient number of discharge measurements have been made they are plotted, using the gage heights of the stream as ordinates and the measured discharges as abscissas. A mean curve is drawn through the plotted points showing the discharge as a function of the gage reading. By means of this curve the average discharge rate for each day is deduced from the record of the height of the stream kept by the gage reader.

The principal sources of error in gaging streams by the current-meter method are due to the effect of slack or nearly slack water in any part of the cross section, to backwater from dams, obstructing ice, or from tributaries entering below the gaging station, thereby causing the river stage to rise at times without a proportional increase in the discharge. In accordance with the well-known Kutter formula, the volume of flow in an open channel is a function of the slope, area of cross section, and wetted perimeter. When a stream is rising, the

slope is usually greater at a given stage of the stream than at the same stage when falling. Northern streams as a rule rise rapidly and fall gradually, so that the stream is falling on the majority of days of the year. The error from the above source is small, inasmuch as the discharge varies only as the square root of the slope. The principal difficulty encountered results from freezing over of streams in winter. The ice serves greatly to increase the wetted perimeter of the measuring section, thereby modifying the rating curve. Whenever practicable, discharge measurements during winter months are made through the ice. The accuracy of individual current-meter measurements depends chiefly upon the number of velocity observations taken in the cross section.

Owing to rapid fall, with frequent rifts, backwater from dams, obstruction by ice, and other characteristics of New York streams, the difficulty of maintaining continuous gaging records which will show with sufficient accuracy the discharge rate day by day throughout the year is very great. This is especially true in streams whose discharge fluctuates between wide limits.

The discharge of the Lower Mohawk at Rexford Flats and Schenectady, for example, varies from 500 to 55,000 second-feet or more. In such cases methods of gaging applicable at low and ordinary stages may not give equally reliable results during freshets, or the reverse may be true, the results being most accurate for high water.

In connection with the meter stations it is necessary to employ as gage readers persons living near the site selected for the measuring section and who have, as a rule, had no previous experience in similar work. Their observations are forwarded at the end of each week. As a check on the records so obtained inspection trips are made at frequent intervals and independent gage readings taken by the hydrographer. On receipt of the gage reader's record for the corresponding period the two sets of observations are compared. The close agreement found in most cases testifies to the intelligent and careful work of the observers.

At the beginning of the work in 1900 many of the older stations were neglected and the painted gage boards originally used were worn out. The stations have been equipped throughout with heavy hardwood or cypress gages having brass or galvanized metal figures and division marks. At a number of current-meter stations where there was no opportunity to secure vertical gages in permanent position weight and wire gages are used. These are perhaps less accurate than direct reading vertical gages, but convenience and freedom from ice obstruction are in their favor. Sometimes a weight gage is attached to the guard rail of the bridge. A more usual method is to secure it by outriggers to the horizontal bridge chords in such a manner as to be least disturbed by traffic and to permit the removal or renewal of the bridge floor planks without disturbing the gage.

In this connection acknowledgment is made of the services of those who have assisted in the field work and in the preparation of this report. Special credit is due to J. D. Luther and M. T. Reilly.

Gaging stations on New York streams.

Location.	Stream.	County.	Drainage area at gaging station.
			Sq. miles.
Baldwinsville	Seneca River	Onondaga	3,103
Binghamton	Chenango River	Broome	1,582
Do	Susquehanna River	do	2,400
Brewerton	Oneida River	Onondaga	
Bridgeport	Chittenango Creek	Madison	307
Chittenango	do	do	[a] 77
Croton dam (old)	Croton River	Westchester	339
Dolgeville	East Canada Creek	Herkimer	256
Dover Plains	Tenmile River	Dutchess	195
Dunsbach Ferry	Mohawk River	Saratoga	3,340
East Nassau and Wilson's dam	Kinderhook Creek	Rensselaer	120,68
Felts Mills	Black River	Jefferson	
Fort Edward	Hudson River	Saratoga	2,800
Fort Hunter dam and aqueduct	Schoharie Creek	Montgomery	947
Fort Montgomery	Richelieu River	Clinton	[b] 7,750
French's Mill	Normanskill Creek	Albany	111
Gaylordsville (Conn.)	Housatonic River	Litchfield	1,020
Glenham	Fishkill Creek	Dutchess	198
High dam[a]	Oswego River	Oswego	5,000
Minetto Cable Station[b]	do	do	4,990
Fulton[c]	do	do	4,916
Hannawa Falls	Raquette River	St. Lawrence	967
Honk Falls	Rondout River	Ulster	88
Indian Lake dam	Indian River	Hamilton	146
Johnstown	Cayadutta Creek	Fulton	40
Kenwood	Oneida Creek	Madison	59
Kingston	Esopus Creek	Ulster	312
Little Falls	Mohawk River	Herkimer	1,306
Mechanicville	Hudson River	Saratoga	4,500
Middleville	West Canada Creek	Herkimer	518
Millpoint and Aqueduct	Schoharie Creek	Montgomery	934
Moose River	Moose River	Lewis	346
McConnellsville	West Branch Fish Creek	Oneida	187
New Paltz	Wallkill River	Ulster	735
New York Mills and Yorkville	Sauquoit Creek	Oneida	52,67
Oriskany State Dam and Woods Road.	Branch Oriskany Creek	do	[c] 144,143
Pulaski	Salmon River	Oswego	264
Rexford Flats	Mohawk River	Saratoga	3,385
Rochester	Genesee River	Monroe	2,365
Rosendale	Rondout Creek	Ulster	365
Ridge Mills	Mohawk River	Oneida	153
Schenectady	do	Schenectady	3,321
Schoharie Falls	Schoharie Creek	Montgomery	930
South Cairo	Catskill Creek	Greene	260
Tisses Bridge, below Croghan	Beaver River	Lewis	242
Twin Rock Bridge	West Canada Creek	Oneida	352
Utica	Mohawk River	do	500
Warrensburg	Schroon River	Warren	563
Watertown	Black River	Jefferson	1,889
Willow Glen and Jordan	Skaneateles Outlet	Onondaga	74,.93
Skaneateles State dam	do	do	73
Rocky Rift dam	Mohawk River	Herkimer	1,351

[a] Including area of diversion from Chenango watershed.
[b] Area taken above Chambly Dam, Province of Quebec.
[c] Additional area of 87 square miles is made tributary in summer by diversion from Chenango watershed.

FORMULAS.

The following hydraulic formulas have been employed in the calculation of gaging records. They are frequently referred to by name in the report, and are given here for reference.

WEIR FORMULA.

This name has been given to the general expression for flow over a weir or dam in its simplest form.

$$Q = CLH^{\frac{3}{2}}. \tag{1}$$

This may also be written:

$$Q = \tfrac{2}{3}\,KLH\sqrt{2gH} = MLH\sqrt{2gH}. \tag{2}$$

Q = volume of discharge in second-feet.

$$C = \tfrac{2}{3}\,K\sqrt{2g} = m\sqrt{2g}. \tag{3}$$

L = length of crest or clear overflow, feet corrected for end contractions, if any.

H = head on crest corrected for velocity of approach, if any.

C, K, and M are constants, determined by experiments.

FRANCIS FORMULA FOR A SHARPED-EDGED WEIR.[a]

$$Q = 3.33\ LH^{\frac{3}{2}}. \tag{4}$$

If the weir has end contractions:

$$L = l - 0.1nH. \tag{5}$$

l = actual length of crest, feet.

n = number of complete contractions.

If the approaching stream has an appreciable average velocity in the cross section of the leading channel opposite the point where h is measured:

$$H = [(h + d)^{\frac{3}{2}} - d^{\frac{3}{2}}]^{\frac{2}{3}}. \tag{6}$$

h = actual measured head on weir, feet.

d = head due to mean velocity V, in the leading channel.

FRANCIS FORMULA FOR MERRIMAC DAM.[b]

$$Q = 3.01208\ LH^{1.53}. \tag{7}$$

MULLIN'S FORMULA.[c]

This is used by East Indian engineers in designing irrigation works.

$$Q = \tfrac{2}{3}cLH\sqrt{2gH}. \tag{8}$$

For a sharp-edged weir:

$$c = 1 - \left(\frac{0.04\,(34.6 + H)}{4}\right) = 0.654 - 0.01\ H. \tag{9}$$

For a broad-crested weir C′ is used.

$$C' = c - \left(\frac{0.025c\ \ (B + 1)}{H + 1}\right). \tag{10}$$

B = width of flat crest, in feet.

[a] Lowell Hydraulic Experiments, J. B. Francis, pp. 112-120.
[b] Ibid., pp. 136-137.
[c] Mullin's Irrigation Manual, pp. 138-139.

BAZIN'S FORMULA.[a]

$$Q = MLh\sqrt{2gH}. \tag{11}$$

M is a coefficient experimentally determined by Bazin for thin-edged and various other forms of weirs. This formula differs from those given above in that the coefficient M includes the correction for velocity of approach, the measured head h being applied directly in the formula.

FORMULA FOR ORIFICES.

$$Q = CA\sqrt{2gH}. \tag{12}$$

C is a variable coefficient, its value depending on the degree of contraction in area of the issuing jet.

A = area of orifice, square feet.

This formula is applied to submerged orifices by making H the difference in elevation of the water surface on the upstream and downstream sides.

If the water approaches the orifice with an appreciable velocity, a correction is applied to the measured head in a manner similar to that used for weirs.

DESCRIPTION OF TABLES OF DAILY DISCHARGE.

The object of the stream gagings, briefly stated, is to determine for each day the volume of flow or rate of discharge of the stream measured.

For mill streams, where the water is held back as pond storage during the dry season, it is impossible to determine the natural regimen of flow of the stream. This is especially true with reference to Sundays or holidays when mills are not running. If, at the time the water wheels are stopped, the water stands below the level of the crest line of the dam, the flow in the stream channel below will be nil, or, at best, will only equal the leakage of the dam, flumes, or penstocks.

With regard to estimation of Sunday flows no uniform rule has been followed. In case of some of the older records the Sunday flow during the dry season has been taken as the mean of the calculated flows for the preceding and following days, and this method, where previously used, has been adhered to. In other instances the flow given in the table for each day is that shown by the gaging record, and represents, as nearly as may be, the actual amount of water flowing in the stream channel below the dam, but may be quite different from the amount entering the pond above the dam.

The relation existing between the canals of New York and the streams of the central portion of the State is very implicit. Diver-

[a] Annales des Ponts et Chaussee's, Oct., 1888.

sion from the headwaters of a number of streams for the supply of canals virtually reduces their effective drainage areas. As a result the summer watershed may be materially less in area and differ widely in its water-yielding characteristics from the region tributary to the stream when the canals are not in operation.

It often happens that a single gage reading, taken at or near the culmination of a flood, shows a larger flow than the mean for any single day.

The results of such isolated observations, together with other data relative to extremes of flow, have been given for a number of stations. Where two or more gage readings are taken each day, the mean of the readings for twenty-four hour periods is used as an argument in entering rating tables to determine the mean daily flow. Theoretically, the several discharge rates should be separately determined for each gage reading and the average taken. The method of averaging the gage readings is much simpler, and it is believed that the error due to the fact that the discharge increases more rapidly than the stream stage, both for dams and current-meter sections, is well within the limit of error of the results in most cases. Where water fluctuates above and below the crests of dams, due to draft from pondage at mills, the discharge is usually computed for the period when water level is above crest and the equivalent rate of discharge, if the flow were distributed through twenty-four hours, is used.

LAKE ONTARIO DRAINAGE.

This region includes the third river system in magnitude of the State—the Seneca, Oneida, Oswego Basin. The character of the run-off varies from the Genesee River in the west with relatively low rainfall, little forest, and great extremes of flow, to the Black River, draining a region of heavier precipitation, better ground storage, and well-maintained regimen at all seasons.

Most of the streams possess notable waterfalls where they pass from the areas of rock outcrop into the ancient Laurentian lake basin.

MOOSE RIVER BELOW M'KEEVER, HERKIMER COUNTY, N. Y.

A gaging station was established on this stream at Moose River, 4 miles below McKeever railroad station, on June 5, 1900. The section of the channel chosen to be spanned by a cableway has a width of 225 feet, with a nearly flat gravel bottom. A vertical gage board was attached to a pile driven some distance out in the stream beyond the low-water margin, and protected from ice and logs by a floating boom anchored upstream.

Daily gage height, in feet, of Moose River at Moose River, N. Y., for 1901.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	3.25	3.3	1.75	2.45	1.55	1.85	1.2	1.35
2	.....	3.25	3.3	1.4	1.9	2.45	1.7	1.1	1.2
3	.....	3.1	3.9	1.85	1.6	2.45	1.85	1.1	1.3
4	.....	2.8	4.4	1.7	1.35	2.35	2.15	1.2	1.45
5	.....	2.55	3.95	1.4	1.25	2.05	2.05	1.1	1.4
6	.....	2.6	3.4	1.15	.95	1.85	2.0	1.05	1.25
7	.....	2.4	4.4	1.45	1.8	1.65	2.0	.95	1.2
8	.....	2.9	5.15	1.5	1.75	1.45	1.9	.8	1.1
9	.....	2.7	4.1	1.35	1.75	1.4	1.85	.85	1.1
10	.....	2.85	3.7	1.25	2.0	1.35	1.85	.95	1.85
11	3.3	2.8	3.4	1.1	2.2	1.55	1.9	.85	3.45
12	3.35	3.85	3.15	1.1	2.15	1.6	1.95	1.1	.....
13	3.5	4.45	2.7	1.15	1.95	1.75	1.95	1.85	.....
14	3.75	3.75	2.6	1.1	1.75	1.85	2.25	2.85	.....
15	4.55	3.45	1.95	.95	1.55	1.85	2.05	2.3	.....
16	4.55	3.15	1.7	.85	1.45	1.9	2.7	2.15	.....
17	5.2	3.0	1.6	.95	1.6	2.1	2.45	1.95	.....
18	5.55	3.2	1.35	1.6	1.55	2.05	2.4	1.9	.....
19	5.65	4.45	1.4	1.95	1.65	1.8	2.35	1.7	.....
20	5.35	3.65	1.35	1.65	1.6	1.65	2.35	1.9	4.8
21	5.85	3.3	5.85	1.25	1.55	1.5	2.5	1.55	4.4
22	7.1	2.9	5.25	1.1	1.55	1.4	2.35	1.4	3.85
23	6.75	2.9	4.7	1.15	1.45	1.35	2.25	1.3	3.45
24	5.1	2.9	4.5	1.05	1.6	1.4	2.2	1.45	3.35
25	4.65	3.05	3.85	.95	1.65	1.3	2.2	1.35	3.15
26	4.4	3.25	3.3	1.1	1.55	1.25	2.15	1.15	2.95
27	4.0	2.85	2.85	.95	1.45	1.25	1.95	1.35	2.75
28	3.5	2.85	2.5	1.05	1.25	1.25	1.75	1.4	2.55
29	3.4	3.25	3.25	2.5	.95	1.5	1.75	1.55	2.35
30	3.55	3.55	1.95	3.35	.65	1.9	1.35	1.4	2.15
31	.....	3.55	.....	3.35	.85	.....	1.2	.....	1.95

This stream is characterized throughout its entire course by rifts and rapids. Topographically the watershed is rocky, precipitous, and mostly timbered. The drainage area above the gaging station is 346 square miles. An area of 41 square miles in the headwaters is subject to regulation by storage, controlled by a State dam at Old Forge, at the foot of the Fulton chain of lakes.

There are numerous undeveloped water powers on the stream, including two falls near Lyonsdale, where a head of 30 feet or more might be obtained, and Millers Falls, below Moose River, of nearly equal height.

Water power is developed at eight dams, utilizing a total fall of 225 feet, with an aggregate capacity of the turbines installed of over 7,000 horsepower.

Lumbermen's dams at the foot of several principal lakes hold back a portion of the waters of the spring freshet to be used for log driving.

No current-meter measurements have thus far been made. Gage readings are taken twice daily, morning and evening, by Chris. Hannon, and the mean of the two readings for each day is shown in the accompanying tables:

Principal developed water powers on Moose River.

No. of dam.	Mills at dam.	Location.	Effective head, in feet.	Horse-power of water wheels.	Number of employees.	Manufacture.
1	1	Near Lyons Falls	18	560	50	Wood pulp.
2	1	do	30	1,208	31	Do.
3	1	do	35	1,736	28	Do.
4	1	Lyonsdale	30	850	35	Do.
5	1	do	30	400	2	Paper.
6	1	do	35	1,252	40	Pulp and paper.
7	1	Above Lyonsdale	30	1,000	40	Manila paper.

BEAVER RIVER AT TISSE'S BRIDGE, LEWIS COUNTY, N. Y.

Beaver River rises in western Hamilton County, crosses Herkimer County, and emerges from the Adirondacks at No. Four, on the Lewis County line. The flow from the tributary watershed above Beaver, comprising an area of 153 square miles, or 47.5 per cent of the entire drainage area, is regulated by storage in the Beaver flow or "stillwater," an artificial lake formed by a timber dam 16 feet high.

In addition to the reservoir formed by the State dam at Beaver, there are in this region over 50 natural lakes, including Red Horse Chain, so that a comparatively uniform flow of the stream is maintained throughout the summer season.

From the State dam at Beaver to No. Four, a distance of 10 miles, the stream consists of numerous bowlder rapids alternating with short stretches of smooth water. Above Beaver Lake occurs a fall with a descent of 60 feet within 400 or 500 feet. From the foot of Beaver Lake to Belfort, a distance of 12 miles, the stream channel continues rocky and precipitous, although the adjacent watershed is sandy and for the most part covered with timber. Eagle Falls, 2 miles below Beaver Lake, consists of a series of cascades aggregating a descent of 75 feet. There are a number of other undeveloped water powers in this vicinity. Water power is developed at Beaver Falls, Croghan, and Belfort, aggregating 4,400 horse power at five dams, and utilizing a fall of 133 feet. There is also an abandoned power at Tisses Falls, where a head of 16 feet could be obtained. Power is developed at Belfort under a head of 50 feet, for the generation of electricity, which is transmitted to adjacent towns, a distance of 16 miles.

An examination of Beaver River, in relation to facilities for gaging, was made in July, 1900. The almost continuous rapids in the upper reaches of the stream, coupled with the fact that all stretches of smooth water are filled with logs much of the time, make the selection of a site for a permanent gaging station very difficult. Tisse's bridge, crossing the river between the villages of Croghan and Belfort, was finally chosen, and a gaging record started May 10, 1901. The bridge crosses the stream at the head of Tisses Falls at a point where the gagings will be unobstructed by either log booms or ice. The bridge consists of two spans of 70.5 and 51.5 feet width

crossing two arms of the stream on opposite sides of a wooded, rocky island, one-half acre in extent.

A 12-foot cypress gage, divided to feet and tenths, was secured to the downstream face of the right-hand abutment of the right span. The bench mark is a chiseled "0" in the bridge seat above the gage board.

Elevation of bench mark	100.00
Elevation gage zero	88.70

One observation of the river stage is taken each day by the gage reader, Nicholas Tisse.

Owing to the existence of cross currents under the bridge, current-meter observations of the velocity have been taken in every square foot of the cross section of the stream, and the direction of flow of the corresponding filaments, as well as their velocity, is taken into consideration in calculating the discharge. The results of current-meter measurements are shown below:

Daily gage height, in feet, of Beaver River at Tisse's bridge, Croghan, N. Y., for 1901.

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1		3.1	2.1	2.1	3.6	2.5	2.6	2.5
2		3.1	2.1	2.0	1.6	2.7	2.7	2.6
3		3.3	2.0	1.8	1.7	3.0	2.5	2.7
4		3.5	2.0	1.2	1.7	3.1	2.5	2.6
5		3.6	2.1	2.0	2.7	2.8	2.5	2.7
6		3.5	2.1	2.0	2.2	2.9	2.4	2.8
7		3.6	2.1	2.1	2.2	2.8	2.5	2.7
8		3.5	2.1	2.1	2.0	2.7	2.4	2.6
9		3.7	2.0	2.2	2.2	2.8	2.4	2.9
10		3.6	2.1	2.3	1.9	2.6	2.2	2.8
11		3.5	2.0	2.3	2.0	2.7	3.2	2.9
12		3.1	2.0	2.7	1.9	2.5	3.0	3.4
13		2.9	2.0	2.2	2.1	2.8	2.4	3.5
14		2.9	1.9	2.1	2.0	2.9	2.2	3.3
15		2.7	1.9	2.7	2.6	3.0	3.0	6.5
16		2.4	1.9	2.3	2.6	3.0	3.1	5.4
17	2.9	2.2	1.8	2.2	2.8	3.0	2.8	4.3
18	2.4	2.2	1.9	1.3	2.7	2.9	2.9	4.0
19	2.4	2.3	1.9	1.3	2.6	3.0	2.7	4.2
20	2.1	2.7	1.8	1.3	2.5	2.9	2.8	3.9
21	2.2	2.9	1.6	1.5	2.3	2.9	2.6	3.8
22	2.5	2.9	1.6	1.5	2.2	2.8	2.6	3.8
23	2.0	2.3	1.4	2.0	2.3	2.3	2.4	3.7
24	2.4	2.9	2.3	2.5	2.4	3.0	2.5	3.4
25	2.0	2.6	2.3	2.3	2.2	2.3	2.7	3.3
26	2.7	2.6	1.2	2.2	2.3	2.3	2.8	3.4
27	2.1	2.4	2.2	1.4	2.3	2.8	2.7	3.6
28	2.9	2.5	2.0	1.6	1.1	2.8	2.8	3.4
29	2.9	2.9	2.9	1.8	1.2	2.8	2.8	2.9
30	3.0	2.3	2.7	1.9	2.0	3.0	2.7	2.9
31	2.8	.....	2.7	2.0	.....	2.6	.....	2.9

Discharge measurements of Beaver River at Tisse's bridge, Croghan, N. Y.

Date	Gage height.	Discharge.
1901.	*Feet*	*Second-feet.*
July 4	2.02	283
May 29	2.98	521
June 10	3.50	997

The drainage area of Beaver River above Castorland, where it empties into Black River, is 322 square miles. The drainage area above the gaging station at Tisse's bridge is approximately 242 square miles.

Rainfall and other meteorological records have been kept since January, 1889, at No. Four, in the heart of the timber-covered portion of the watershed.

BLACK RIVER AT HUNTINGTONVILLE, JEFFERSON COUNTY, N. Y.

This river rises in Herkimer County and flows in a northeasterly direction into Black River Bay, an arm of Lake Ontario. A portion of its course is shown on the Watertown atlas sheet of the United States Geological Survey. Observations of the height of water have been made at the dam of the city waterworks of Watertown, located 2 miles above, at Huntingtonville. The station was established on February 22, 1897, and the record has been furnished by Frank A. Hinds, M. Am. Soc. C. E.[a]

The conditions at this point are peculiar, in that the stream flows in two channels, with an island between. A high timber dam on the right branch creates a settling basin for the water supply of the city of Watertown. The other dam, on the opposite side of the island, is also of timber, and gage readings are taken at a point about 500 feet above this dam. The crest of the dam is slightly irregular in profile, and for ease of computation has been divided into six parts, each of these being considered as horizontal. There is an elbow in the plan of the dam, with its apex downstream, the juncture of the two wings being strengthened by a timber buttress, having a flat crest or platform.

The discharge over the dam proper has been computed, using coefficients derived from experiments on a dam having a similar cross section, with a slope 2:1 on the upstream face, while the discharge over the flat platform has been computed from an experiment on a somewhat similar broad-crested weir.

The entire flow of Black River at this point, aside from leakage and a slight diversion for municipal water supply of Watertown, passes over the Huntingtonville dam. Two or more readings of the crest gage are taken daily, and the mean of all readings from midnight to midnight has been used in estimating the mean daily flow. In computing the flow over the dam an allowance of 200 second-feet has been made for leakage through seams and crevices in the limestone rock underlying the dam. This amount has been arrived at from an estimate of the size of the orifices and the head on the same when the water was drawn down in the summer of 1897.

There is no opportunity for directly checking the flow during high

[a] See Water Supply and Irrigation Paper, U. S. Geol. Survey, No. 36, p. 131.

water immediately below the dam. A current-meter measurement was made at Glen Park bridge on June 6, 1900, which gave a total flow of 2,175 second-feet. The mean daily flow is given in the following table. It does not represent the full water-yielding capacity of the tributary drainage area, inasmuch as a portion of the flow from the headwaters is diverted to the Forestport feeder to supply Black River Canal. Storage reservoirs to compensate water-power users are maintained by the State of New York on Beaver and Moose rivers, the principal tributaries of Black River. These are described in connection with gaging stations on the streams named.

Reservoirs and lakes on the headwaters of Black River and Woodhull Creek are also utilized for storage for the supply of Boonville feeder of Black River Canal, affording a total water-surface area of 6 square miles, receiving drainage from 267 square miles of watershed and having a total storage capacity of 1,220,155,000 cubic feet.[a]

Measurements of the amount of diversion from Black River below Forestport reservoir, made in connection with the Barge Canal Survey, are described on page 143 of this report.

Above Lyons Falls the watershed of Black River is mountainous and largely timbered. At Lyons Falls Black River is joined by Moose River, and the two flow over a declivity—a limestone rock of 67 feet. From the foot of Lyons Falls to Carthage, a distance of 29 miles, the stream flows through a broad, drift-filled valley, the current is sluggish, and the river is utilized for slack-water navigation. From Carthage to the mouth of the stream, a distance of 25 miles, the stream channel is mostly underlain by limestone rock, affording numerous ledges utilized as sites for dams, making the stream of great importance as a source of water power. There are 22 dams in this section, furnishing, roundly, 60,000 horsepower to 80 mills along the banks, which employ an aggregate of 3,900 persons.[b]

On the morning of April 21, 1900, the calculated discharge over the Huntingtonville dam was 30,150 second-feet, equivalent to a flow of 16 second-feet per square mile of tributary watershed. December 15, 1901, heavy rainfalls on frozen ground produced a freshet, yielding a calculated discharge of over 37,000 second-feet at the Huntingtonville dam, or 19.2 second-feet per square mile.

[a] See Report of New York Barge Canal Survey, 1901, pp. 666-672.

[b] Black River water power is fully described in Report of U. S. Board of Engineers on Deep Waterways, Vol. II, pp. 841-868.

Mean daily flow, in second-feet, of Black River at Huntingtonville dam, Jefferson County, N. Y., for 1901.

[Drainage area, 1,889 square miles.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3,530	2,455	2,930	12,080	9,120	5,250	2,225	3,863	[a]5,750	3,350	1,925	[a]2,532
2	2,930	2,378	2,531	11,150	8,260	[a]5,450	2,000	3,178	7,010	3,420	1,850	4,574
3	2,610	[a]2,000	[a]2,225	11,280	7,120	5,950	2,000	2,300	7,450	3,420	[a]1,850	5,250
4	2,610	2,770	2,455	11,410	6,680	6,470	1,340	[a]1,850	5,950	3,600	1,710	4,038
5	2,455	2,300	2,610	11,020	[a]6,630	6,900	1,580	1,580	5,450	3,515	1,785	3,345
6	[a]2,531	1,220	2,610	10,370	5,350	6,790	1,520	1,710	3,863	[a]3,260	1,850	2,930
7	2,770	2,378	2,658	[a]9,990	4,758	6,856	[a]1,460	1,850	2,800	3,260	1,895	2,455
8	2,610	2,075	2,610	11,020	4,393	7,900	1,710	2,455	[a]1,925	3,012	1,850	[a]2,225
9	2,770	2,000	2,610	11,280	3,600	[a]8,750	1,850	2,770	.....	2,610	1,520	2,532
10	3,012	[a]1,910	[a]2,455	11,410	3,345	8,875	1,580	2,610	2,000	2,610	[a]1,165	5,850
11	3,260	2,690	2,930	10,630	3,515	8,380	1,520	[a]2,850	1,850	2,579	1,580	8,020
12	3,178	2,455	3,420	9,740	[a]4,574	7,120	1,644	3,600	1,925	2,532	1,710	8,020
13	[a]3,178	2,225	4,032	9,240	5,450	5,750	1,520	3,311	2,377	[a]2,455	3,515	8,260
14	3,178	2,300	4,300	[a]9,490	6,155	4,665	[a]1,280	2,770	3,260	3,775	4,950	([b])
15	3,095	2,225	4,213	11,020	5,650	3,420	1,580	2,150	[a]2,930	4,300	4,665	([a])
16	2,930	2,300	4,213	11,675	4,950	[a]2,850	1,280	1,984	3,775	4,484	3,950	.....
17	3,012	[a]2,000	[a]3,775	13,750	4,213	2,300	1,165	1,644	3,775	4,484	[a]3,420	.....
18	3,178	2,300	3,950	16,300	3,685	2,270	1,143	[a]1,460	4,038	5,050	3,600	.....
19	3,260	2,378	4,125	19,000	[a]3,515	1,962	1,280	1,580	3,515	4,758	3,260	.....
20	[a]2,770	2,610	4,032	21,000	4,665	1,850	1,165	1,520	3,178	[a]4,213	3,095	.....
21	3,095	2,610	5,050	[a]21,000	5,050	3,008	[a]800	1,644	2,610	4,038	2,930	.....
22	3,012	2,770	5,850	21,400	4,850	6,150	1,460	1,520	[a]2,376	3,862	2,850	.....
23	2,930	2,850	5,850	22,650	4,484	[a]7,670	1,400	1,580	2,075	3,345	2,690	.....
24	2,770	[a]2,690	[a]5,450	24,800	4,300	7,780	1,400	2,000	2,000	2,770	[a]2,930	.....
25	2,690	3,260	6,365	23,350	4,300	6,260	1,436	[a]2,000	1,850	2,690	3,950	.....
26	2,610	2,770	10,760	19,700	[a]4,076	5,350	1,400	1,785	1,850	2,770	3,600	.....
27	[a]2,225	2,930	16,800	16,800	4,038	5,850	1,165	1,710	1,735	[a]2,610	2,300	.....
28	2,610	2,930	18,200	[a]14,520	4,336	3,420	[a]1,165	1,580	1,580	2,455	3,013	.....
29	2,455	.....	17,800	12,780	4,178	2,930	1,850	1,340	[a]1,165	2,532	3,095	([a])
30	2,531	.....	15,000	10,780	4,813	[a]2,300	3,008	1,460	2,610	2,376	2,850	.....
31	2,378	.....	[a]14,050	10,760	5,150	.....	4,484	2,530	.....	2,075	.....	.....
Mean	2,844	2,421	6,024	14,354	5,007	5,316	1,626	2,135	3,089	3,316	2,712	.....

[a] Sunday. [b] Dam injured by high water.

Mean monthly run-off of Black River at Huntingtonville dam, New York.

[Drainage area, 1,889 square miles.]

MEAN MONTHLY FLOW IN SECOND-FEET.

Month.	1897.	1898.	1899.	1900.	1901.
January	.....	3,402	4,712	2,834	2,844
February	2,160	3,806	2,326	5,734	2,421
March	6,317	9,609	5,051	2,970	6,024
April	9,484	4,654	13,894	13,926	14,354
May	4,267	3,174	5,609	5,711	5,007
June	2,713	1,639	1,528	1,630	5,316
July	879	1,128	1,205	1,321	1,626
August	2,280	1,495	897	1,134	2,135
September	.....	1,483	990	1,020	3,089
October	954	3,138	1,018	1,218	3,316
November	4,155	3,932	1,652	5,014	2,712
December	4,725	2,720	3,501	4,230	.....
Year	.....	3,348	3,532	3,895	.....

RUN-OFF IN SECOND-FEET PER SQUARE MILE.

January	.....	1.18	2.49	1.50	1.50
February	1.14	2.01	1.23	3.04	1.28
March	3.34	5.08	2.67	1.57	3.18
April	5.02	2.46	7.35	7.37	7.60
May	2.26	1.68	2.97	3.02	2.65
June	1.44	.87	.81	.86	2.81
July	.47	.60	.64	.70	.86
August	1.21	.79	.47	.60	1.13
September	.....	.78	.52	.54	1.63
October	.505	1.66	.54	.64	2.28
November	2.20	2.08	.87	2.65	1.43
December	2.50	1.44	1.85	2.24	.....
Year	.....	1.72	1.87	2.06	.....

Mean monthly run-off of Black River at Huntingtonville dam, New York—Cont'd.

RUN-OFF IN INCHES ON DRAINAGE AREA.

Month.	1897.	1898.	1899.	1900.	1901.
January	.....	1.36	2.77	1.73	1.73
February	1.18	2.09	1.28	3.16	1.33
March	3.85	5.77	3.08	1.81	3.66
April	5.60	2.74	8.20	8.22	8.51
May	2.60	1.86	3.42	3.48	3.05
June	1.60	.97	.90	.96	3.15
July	.54	.69	.73	.80	.99
August	1.39	.91	.54	.69	1.30
September	.....	.87	.58	.60	1.83
October	.58	1.91	.60	.71	2.62
November	2.45	2.32	.97	2.96	1.60
December	2.88	1.66	1.52	2.58	.....
Year	.....	23.15	24.59	27.70	.....

Estimated flood discharge of Black River in April, 1869.[a]

Location.	Estimated discharge.	Drainage area.	Discharge per square mile of drainage area.
	Sec.-feet.	*Sq. miles.*	*Sec.-feet.*
Forestport	10,450	268	39
Lyons Falls	40,400	878	46
Carthage	39,529	1,812	21
Four miles below Carthage	39,009	1,824	21
Below Black River	39,137	1,869	21
Watertown	39,696	1,892	21
Ontario Paper Mill	28,337	1,903	15

[a] From data by L. L. Nichols, Black River Water Claims, vol. 1, p. 640.

SALMON RIVER ABOVE PULASKI, OSWEGO COUNTY, N. Y.

Salmon River rises in Lewis County, flows westward across Jefferson County, and enters the east end of Lake Ontario near Pulaski. A current-meter station was established on this stream September 5, 1900. It is located at a highway bridge, locally called Fox Bridge, 2 miles above the village of Pulaski. The stream bed is of gravel and cobblestone, nearly flat. The gage board is attached to the central pier of the bridge, and is divided in feet and decimals, from zero to 10 feet. Gage readings are taken each morning and evening by Hiram A. Walker. The capstone of the central pier, above the gage, is used as a bench mark.

Elevation bench mark	100.00
Elevation gage zero	87.41

The stream has a flood plain on the left-hand side, over which the water passes during freshets. The average elevation of the flood plain is 7.5 feet above gage zero. There are two auxiliary channels, spanned by short bridges, through which the water passes at times. The flow through these is included in the high-water discharge measurements given below.

Current-meter discharge measurements of Salmon River near Pulaski, N. Y.

Date.	Gage height.	Discharge.	Hydrographer.
	Feet.	*Second-feet.*	
Sept. 4, 1900	1.03	102	R. E. Horton.
May 21, 1901	1.69	422	J. D. Luther.
May 13, 1901	2.14	824	R. E. Horton.
June 1, 1901	2.50	1,070	J. D. Luther.
Apr. 12, 1901	3.40	2,536	R. E. Horton.
June 8, 1901	4.10	3,437	J. D. Luther.
Apr. 24, 1901	4.30	3,476	R. E. Horton.

A current-meter measurement of Salmon River at Stillwater Bridge was made November 2, 1898, by W. D. Lockwood, the discharge being 403 second-feet.

Drainage area of Salmon River.

Location.	Drainage area.
	Sq. miles.
Gaging station near Salmon Falls	191
Gaging station near Pulaski	264
Mouth of stream	285

Summary of developed water powers on Salmon River.

No. of dam.	Location.	Number of mills.	Head, in feet.	Horse-power of water wheels.	Number of operatives employed.	Manufacture.
1	Pulaski	2	10	136	10	Electric-lighting; furniture.
2	do	1	4	30	2	Gristmill.
3	do	4	4-9	70	18	Wood working, etc.
4	do	6	10-13	82	22	Wood and iron working and woolen mill.
5	Altmar	2	5-7	119	4	Grist and planing mills.
6	Stillwater	1	6	6	10	Sawmill.

Mean daily flow, in second-feet, of Salmon River at Pulaski, N. Y., for 1900.

[Drainage area, 264 square miles.]

Day.	Sept.	Oct.	Nov.	Dec.	Day.	Sept.	Oct.	Nov.	Dec.
1		394	186	1,075	18	100	282	458	234
2		330	186	905	19	100	258	1,131	394
3		258	554	820	20	100	258	3,541	618
4		210	522	1,075	21	777	234	3,748	282
5		186	490	1,357	22	862	210	2,566	306
6	100	114	586	1,032	23	490	210	1,777	394
7	100	138	586	905	24	426	306	1,032	862
8	100	258	1,357	777	25	362	650	1,075	1,075
9	100	554	1,131	426	26	258	618	2,325	990
10	100	522	862	330	27	210	554	4,656	820
11	75	394	586	330	28	210	554	2,727	820
12	75	330	586	282	29	210	458	2,119	735
13	75	282	522	282	30	306	490	1,131	820
14	75	282	522	282	31		490		905
15	75	234	458	258					
16	100	282	330	234	Mean	219	343	1,267	641
17	100	282	330	234					

Mean daily flow, in second-feet, of Salmon River at Pulaski, N. Y., for 1901.

[Drainage area, 264 square miles.]

Day.	Jan.	Feb	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
	(a)	(a)	(a)								
1	.....	.....	.....	1,244	1,640	1,301	306	458	5,276	1,301	586
2	.....	.....	.....	1,357	3,439	1,131	282	362	2,051	990	426
3	.....	.....	.....	1,777	1,244	1,188	282	258	1,301	1,131	362
4	.....	.....	.....	2,566	1,075	1,583	282	234	735	1,470	306
5	.....	.....	.....	2,405	1,032	2,051	282	186	554	1,470	330
6	.....	.....	.....	2,727	947	1,527	306	186	458	1,131	330
7	.....	.....	.....	3,130	650	1,131	330	330	394	1,032	330
8	.....	.....	.....	2,727	490	4,057	394	282	362	905	282
9	.....	.....	.....	2,727	458	2,486	458	258	306	820	282
10	.....	.....	.....	2,727	490	1,301	426	490	282	1,244	282
11	.....	.....	.....	2,119	947	1,131	394	522	362	650	306
12	.....	.....	.....	3,130	862	905	330	490	490	394	1,414
13	.....	.....	.....	2,808	862	618	306	394	905	777	4,284
14	.....	.....	.....	2,119	735	490	306	330	258	1,470	2,256
15	.....	.....	.....	4,057	618	458	282	282	618	1,131	1,357
16	.....	.....	.....	4,408	554	426	282	306	1,914	1,032	1,131
17	.....	.....	.....	4,656	650	394	258	282	1,075	1,527	1,075
18	.....	.....	.....	(b)	554	394	234	234	947	1,640	990
19	.....	.....	.....	5,276	490	426	186	234	735	1,470	918
20	.....	.....	.....	(b)	458	394	186	234	522	1,188	863
21	.....	.....	.....	(b)	490	1,527	138	234	458	947	778
22	.....	.....	.....	(b)	426	905	138	186	394	905	618
23	.....	.....	.....	(b)	618	1,470	138	306	394	777	778
24	.....	.....	.....	4,656	454	905	138	990	362	458	820
25	.....	.....	.....	3,954	586	1,244	138	586	330	554	650
26	.....	.....	.....	3,233	458	905	138	426	330	522	586
27	.....	.....	.....	2,486	490	490	138	306	282	458	522
28	.....	.....	.....	2,486	618	394	138	234	282	458	394
29	.....	.....	.....	1,982	947	362	426	186	282	458	330
30	.....	.....	.....	1,708	990	362	554	490	947	458	330
31	.....	.....	.....	.....	1,301	.....	490	3,954	.....	458	.....
Mean	.....	.....	.....	2,894	829	1,065	281	460	787	943	798

[a] Stream obstructed by ice. [b] Exceeds limit of rating curve.

Mean monthly run-off of Salmon River at Pulaski, N. Y.

[Drainage area, 264 square miles.]

Month.	Mean monthly flow in second-feet.		Run-off in second-feet per square mile.		Run-off in inches on drainage area.	
	1900.	1901.	1900.	1901.	1900.	1901.
April	.....	2,894	.....	10.95	.....	12.21
May	.....	829	.....	3.14	.....	3.61
June	.....	1,065	.....	4.02	.....	4.50
July	.....	281	.....	1.06	.....	1.22
August	.....	460	.....	1.74	.....	2.00
September	219	787	0.83	2.98	0.93	3.34
October	343	943	1.30	3.57	1.50	4.12
November	1,267	798	4.81	3.02	5.39	3.37
December	641	930	2.43	3.52	2.79	4.06

There is an undeveloped water power with a precipitous fall of 110 feet at Salmon Falls. In November, 1898, a gaging station was established by United States Board of Engineers on Deep Waterways, at a dam 1 mile above these falls. This gaging station was abandoned in June, 1899.[a]

[a] See description in Water-Supply Paper, United States Geological Survey, No. 36, p. 130.

WEST BRANCH OF FISH CREEK AT M'CONNELLSVILLE, ONEIDA COUNTY, N. Y.

This stream rises in the northern part of Oneida County and flows in a southerly direction to its junction with the east branch at Taberg station, where it forms the main Fish Creek, which stream flows in a westerly direction emptying into the east end of Oneida Lake. The lower part of the course of Fish Creek is shown on the Oneida atlas sheet of the United States Geological Survey.

The station is located at the Harden dam in McConnellsville. This dam is of timber, having a slight leakage, which has been estimated at 10 second-feet. The dam is in two sections, forming an angle in plan, the length of the right-hand and left-hand sections being 102.69 feet and 73 feet, respectively.

During the summer, when flashboards are on the dam, the Francis formula is used in computing the flow. At other times a discharge curve derived from Cornell University experiments is used. Three water wheels are in use. Two are 54-inch wheels, built by the Camden Water Wheel Works, and are usually run ten hours per day at a nearly constant gate opening. The third is a 36-inch Helmer turbine.

Current-meter measurements of the discharge of one of the 54-inch wheels, as run under light and heavy load, showed the following results:

	Second-feet.
June 2, 1900	43.2
September 6, 1900	51.8

The gaging record at McConnellsville was discontinued June 30, 1901.

The following data relative to maximum discharges of Fish Creek were obtained for the United States Board of Engineers on Deep Waterways:[1]

Maximum discharge of Fish Creek.

Location.	Date of flood.	Drainage area.	Estimated maximum discharge.	Discharge per square mile of drainage area.
		Sq. miles.	*Sec.-ft.*	*Sec.-ft.*
Williamstown [a]		16.2	500	30.9
Do. [b]		16.5	561	34.0
West Camden	Spring, 1884	47.5	1,620	34.1
Camden [c]	June, 1889	61.4	1,475	24.1
Do. [d]		61.5	1,417	23.0
Do. [e]		61.5	1,456	23.5
Do. [f]		68.8	1,335	21.9
McConnellsville	1884	187.0	6,170	32.7
Taberg station [g]	Mar. 14, 1898	387.0	5,875	15.2
Fish Creek [h]	Mar. 15, 1898	533.0	7,597	14.2
Point Rock [i]	Fall, 1897	104.3	8,400	36.9

[a] Upper dam.
[b] Lower dam.
[c] Grist mill dam.
[d] Foundry dam.
[e] Planing mill dam.
[f] Dorrance's dam.
[g] Below junction, east and west branches.
[h] Below confluence with Wood Creek.
[i] East Branch.

[1] Report on Special Water-Supply Investigation, pt. 2, pp. 790-791.

The maximum discharge observed while the gaging record has been kept was 4,560 second-feet, or 24.4 second-feet per square mile, March 27, 1901.

Mean daily flow, in second-feet, of West Branch of Fish Creek at McConnellsville, Oneida County, N. Y., for 1901.

[Drainage area, 187 square miles.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	Day.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	150	135	95	620	170	478	18	111	85	290	420	126	320
2	150	135	85	545	170	[a] 540	19	106	100	290	390	[a] 100	310
3	150	[a] 100	[a] 50	915	140	510	20	[a] 110	100	344	358	130	310
4	115	135	85	1,420	140	440	21	136	100	580	[a] 560	130	1,060
5	115	110	38	1,520	[a] 120	355	22	146	90	815	670	150	833
6	[a] 100	130	85	1,210	110	690	23	136	90	730	655	180	[a] 620
7	111	110	85	[a] 1,070	110	710	24	111	[a] 65	[a] 730	530	185	440
8	111	110	88	1,165	95	878	25	111	90	1,050	460	293	310
9	111	110	75	1,060	90	[a] 690	26	111	80	3,020	315	[a] 200	200
10	116	[a] 65	[a] 45	980	90	630	27	[a] 100	90	4,410	258	230	170
11	111	110	115	695	340	570	28	111	90	2,180	[a] 230	220	170
12	111	61	150	620	[a] 460	520	29	125	.....	1,165	235	230	118
13	[a] 100	95	170	630	345	470	30	125	.....	960	170	355	[a] 100
14	130	95	190	[a] 620	220	375	31	105	.....	[a] 730	.....	420	.....
15	125	95	250	540	170	368							
16	121	95	250	470	120	[a] 335	Mean	119	97	625	657	192	463
17	121	[a] 80	[a] 230	425	120	360							

[a] Sunday.

Principal developed water powers on West Branch Fish Creek.

No. of dam.	Location of dam.	Number of mills at dam.	Effective head feet.	Rated horse-power of water wheels.	Number of employees.	Use made of power.
1	Taberg	1	8	.....	.....	Sawmill.
2	McConnellsville	2	6	111	40	Woodworking.
3	Camden	4	7-9	114	22	Do.
4	do	2	9-10	136	220	Foundry and knitting mill.
5	do	1	10	157	2	Gristmill.
6	do	1	5	53	2	Saw and gristmill.
7	West Camden	2	5	92	21	Chair factory.
8	Williamstown	2	16	66	5	Saw and gristmill.
9	do	1	9	185	4	Gristmill.

A current-meter measurement of East Branch of Fish Creek was made at Wilson's bridge, 1 mile above Point Rock Village, May 17, 1900; the discharge was 485 second-feet.

Mean monthly run-off of West Branch of Fish Creek at McConnellsville, N. Y.

[Drainage area, 187 square miles.]

MEAN MONTHLY FLOW IN SECOND-FEET.

Month.	1898.	1899.	1900.	1901.
January	.....	435	.....	119
February	.....	206	.....	97
March	.....	648	.....	625
April	.....	1,206	.....	657
May	.....	239	143	192
June	.....	101	68	463
July	.....	57	60	.....
August	.....	.....	57	.....
September	134	.....	65	.....
October	333	.....	88	.....
November	388	.....	168	.....
December	211	.....	99	.....

Mean monthly run-off of West Branch of Fish Creek, etc.—Continued.

RUN-OFF IN SECOND-FEET PER SQUARE MILE.

Month.	1898.	1899.	1900.	1901.
January		2.33		0.64
February		1.10		.52
March		3.47		3.34
April		6.46		3.51
May		1.28	0.76	1.03
June		.54	.36	2.48
July		.30	.32	
August			.30	
September	0.72		.34	
October	1.78		.42	
November	2.06		.90	
December	1.13		.53	

RUN-OFF IN INCHES ON DRAINAGE AREA.

January		2.68		0.74
February		1.14		.54
March		4.00		3.84
April		7.20		3.93
May		1.47	0.87	1.18
June		.60	.40	2.78
July		.34	.37	
August			.34	
September	0.80		.38	
October	2.07		.48	
November	2.30		1.01	
December	1.30		.62	

ONEIDA CREEK AT KENWOOD, MADISON COUNTY, N. Y.[a]

This stream rises in Madison County and flows in a northwesterly direction, crossing the Erie Canal and emptying into Oneida Lake at its southeastern extremity. It is shown on the Oneida atlas sheet of the United States Geological Survey. The station is located at the dam of Oneida Community at Kenwood, which is of framed timber, having a level crest 79.4 feet in length.

Water is conducted to the mill in an open earth canal, terminating near the silk mill. A short, circular wooden flume conducts water from the headrace to the 24-inch Hercules turbine, which is ordinarily run at one-third gate. There is no leakage of the dam, and only a slight leakage of flume and head gates. This has been taken at 2 second-feet. The flow over a wasteway near the mill is computed by means of the Francis formula. A discharge curve for a second spillway has been prepared, using coefficients from the Cornell experiments for dam with a broad, flat crest.[b]

[a] See Water-Supply and Irrigation Paper, U. S. Geol. Survey, No. 36, p. 186.
[b] See Proc. Am. Soc. Civil Eng., March, 1900, p. 282.

Current-meter measurements, to check the calculated flow at Kenwood, have been made, with results as follows:

Current-meter measurements of Oneida Creek.

		Second-feet.
June 1, 1900, total flow at Oneida Castle		36.6
Flow over dam, crest gage reading 0.15	19	
Flow through turbine, 11.75 head, one-third gate	15	
Flow over waste way near mill	1	
Assumed leakage	2	
Computed total flow		37
September, 17, 1900, total flow measured in headrace		20
Flow through turbine, one-third gate	15	
Assumed leakage	2	
Total flow computed		17

At Oneida is a State dam diverting water for the supply of the summit level of Erie Canal. No measurements of diversion to the feeder have been made. Practically the entire flow of Oneida Creek, less leakage of the dam, is taken for this purpose during the low-water season.

The highest recorded freshet on Oneida Creek occurred in 1892. The calculated discharge over Kenwood dam was 3,292 second-feet, or 41.2 second-feet per square mile. December 15, 1901, a sudden freshet, resulting from excessive rainfall on frozen ground, produced a discharge estimated at 2,075 second-feet, or 35.1 second-feet per square mile, from the tributary drainage area of 59 square miles.

Mean monthly run-off of Oneida Creek at Kenwood, Madison County, N. Y.

[Drainage area, 59 square miles.]

Month.	Mean monthly flow in second-feet.			Run-off in second-feet per square mile.			Run-off in inches on drainage area.		
	1898.	1899.	1900.	1898.	1899.	1900.	1898.	1899.	1900.
January		117	92		1.98	1.56		2.28	1.80
February		93			1.58			1.64	
March		157	148		2.66	2.51		3.06	2.89
April		183	198		3.10	3.35		3.46	3.74
May		62			1.05			1.21	
June		30	21		.51	.35		.57	.39
July		25	38		.42	.64		.48	.74
August			19			.32			.37
September			16			.27			.30
October	83	23	19	1.40	.39	.32	1.61	.45	.37
November	105	33	91	1.78	.56	1.54	1.98	.62	1.72
December	90	60	127	1.52	1.02	2.15	1.75	1.17	2.47

The drainage area tributary to Oneida Creek above its mouth is 149 square miles.

CHITTENANGO CREEK AT BRIDGEPORT, MADISON COUNTY, N. Y.

This creek rises in southwestern Madison County, flows in a northwesterly direction between Madison and Onondaga counties into Oneida Lake, the outlet of which is Oneida River, a tributary of Oswego River. The drainage basin of the stream is shown on Chittenango sheet of the United States Geological Survey. Observations for the computation of flow of this creek are made at the milldam in Bridgeport, a short distance above its mouth. Gage readings are taken three times a day, showing the height of the water above the crest of the dam, head on water wheels, and widths of gate openings. The dam is of timber, backed with stone, and has a nearly level crest 215 feet in length, with flood gates at each end.

A current-meter measurement was made at a highway bridge below the inflow of Butternut Creek, near Bridgeport, on June 16, 1900. The total flow of Chittenango Creek at that point was found to be 95 second-feet. The stage of the stream, as shown by the record kept at Bridgeport, was uniform for several days. The mean flow, as computed from the gage readings, was 95 second-feet for June 15 and 16. There is no opportunity for separately measuring the discharge through the turbines or leakage of the dam at this station, and an allowance of 15 second-feet for leakage of the dam and of the dike leading to the old sawmill has been made.

The sawmill, situated on the left side of the stream, runs very irregularly. The water wheels are old and the penstocks leak badly. A current-meter measurement was made in the headrace leading to the sawmill on June 16. The water wheels were running, and the flow was found to be 14.4 second-feet.

The relatively low run-off from the water shed of Chittenango Creek during the summer months, as shown in the accompanying tables, may be attributed to diversion of a portion of the flow to supply the summit level of the Erie Canal.

State dams are situated on the main stream at Chittenango, and on its two tributaries, Limestone Creek and Butternut Creek, Cazenovia Lake, Erieville, De Ruyter, and Jamesville reservoirs impound storage by which the flow is regulated to some extent.

The first two reservoirs are described in connection with the Chittenango meter station.[a]

De Ruyter reservoir, situated near Delphi, has a capacity of 504,468,000 cubic feet and a water surface area of 626 acres. It receives storage from 18.5 square miles of area naturally tributary to Tioughnioga River, a tributary of Chenango River. The outflow from this reservoir is diverted into Limestone Creek and enters Erie Canal through the Fayetteville feeder.

The Jamesville reservoir is situated on the headwaters of Butternut Creek, which is tributary to Chittenango Creek through Limestone

[a] See page 115.

Creek. The reservoir has a storage capacity of 170,000,000 cubic feet and a water surface area of 252 acres. It receives drainage from 46.2 square miles of watershed. The outflow is turned into Erie Canal through the Orville feeder.

Owing to its location below three feeders of the canal, the records at Bridgeport do not show the actual run-off of the watershed during the canal season. During the winter some water, draining into the summit level of the canal, is drawn off into Chittenango Creek at the aqueducts crossing the main stream and its tributaries. Owing to uncertainty in the run-off of the watershed, derived from this record, the Bridgeport station was abandoned May 31, 1901, and a current meter station established in its stead, above the State dam at Chittenango.

Mean daily discharge, in second-feet, of Chittenango Creek at Bridgeport, N. Y., 1901.

[Drainage area, 307 square miles.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	Day.	Jan.	Feb.	Mar.	Apr.	May.
1	373	210	215	751	360	18	514	285	912	952	286
2	363	255	280	715	323	19	413	229	1,077	883	[a] 275
3	308	[a] 275	[a] 275	920	290	20	[a] 355	195	1,297	838	291
4	303	324	330	1,375	238	21	512	212	1,476	[a] 905	251
5	193	330	296	1,388	[a] 160	22	583	165	1,933	1,056	258
6	[a] 160	264	195.5	1,426	123	23	582	132	1,713	1,276	341
7	256	272	170	[a] 1,365	143	24	577	[a] 165	[a] 1,485	1,466	288
8	306	310	150	1,538	160	25	378	157	1,510	1,306	291
9	307	330	210	2,030	158	26	372	176	1,746	1,330	[a] 275
10	320	[a] 355	[a] 220	1,825	228	27	[a] 355	187	2,805	1,200	311
11	407	322	510	1,531	335	28	328	144	2,385	[a] 425	376
12	592	275	807	1,510	[a] 275	29	342	.....	1,023	440	556
13	[a] 425	250	1,262	1,350	425	30	298	.....	767	433	688
14	424.5	182	1,144	[a] 1,245	381	31	302	.....	[a] 595	.....	741
15	445.5	191	1,116	1,346	256						
16	431	203	1,006	1,200	246	Mean	391	236	955	1,174	308
17	592.5	[a] 220	[a] 690	1,198	222.5						

[a] Sunday.

Mean monthly run-off of Chittenango Creek at Bridgeport, N. Y.

[Drainage area, 307 square miles.]

MEAN MONTHLY FLOW IN SECOND-FEET.

Month.	1898.	1899.	1900.	1901.
January	.....	662	561	391
February	.....	551	725	236
March	.....	893	697	955
April	.....	921	911	1,174
May	.....	245	207	308
June	.....	161	93	.....
July	.....	123	110	.....
August	.....	96	73	.....
September	129	76	68	.....
October	344	64	81	.....
November	612	95	327	.....
December	597	281	562	.....
Year	.....	347	368	.....

Mean monthly run-off of Chittenango Creek, at Brideport, N. Y.—Cont'd.

RUN-OFF IN SECOND-FEET PER SQUARE MILE.

Month.	1898.	1899.	1900.	1901.
January	.....	2.15	1.80	1.27
February	.....	1.80	2.36	.77
March	.....	2.90	2.27	3.12
April	.....	3.00	2.97	3.83
May	.....	.80	.67	1.00
June	.....	.52	.30	.....
July	.....	.40	.36	.....
August	.....	.31	.24	.....
September	0.42	.25	.22	.....
October	1.12	.20	.26	.....
November	2.00	.30	1.07	.....
December	1.94	.91	1.83	.....
Year	.....	1.13	1.20	.....

RUN-OFF IN INCHES ON DRAINAGE AREA.

January	.....	2.49	2.07	1.46
February	.....	1.87	2.45	.80
March	.....	3.34	2.61	3.59
April	.....	3.34	3.31	4.29
May	.....	.92	.77	1.15
June	.....	.58	.33	.....
July	.....	.46	.40	.....
August	.....	.35	.27	.....
September	0.47	.28	.24	.....
October	1.29	.23	.30	.....
November	2.24	.34	1.20	.....
December	2.23	1.05	2.10	.....
Year	.....	15.25	16.05	.....

CHITTENANGO CREEK AT CHITTENANGO, MADISON COUNTY, N. Y.

A current-meter gaging station was established at Main street highway bridge in Chittenango village May 22, 1901. The stream at this point is entrained between parallel walls, affording a channel 50 feet wide, over which the bridge passes in a single span. The bridge stands at an angle of 60° to the thread of the stream, and has a span between abutments of 57 feet. The gage board is secured in a vertical position to the right abutment on the upstream side, and reads decimally from zero to 8 feet. The stage of the stream is observed twice daily by the gage reader, Frank A. Sutter. The bench mark is on the upstream corner of the coping of the right-hand bridge abutment.

Elevation bench mark	100.00
Elevation gage zero	91.77

Current-meter discharge measurements of Chittenango Creek at Chittenango, N. Y.

Date.	Gage height.	Discharge.	Hydrographer.
1901.	*Feet.*	*Second-feet.*	
August 28	1.78	45	R. E. Horton.
Do	1.78	48	Do.
July 15	1.80	58	E. C. Murphy.
May 22	2.03	102	R. E. Horton.
June 5	2.3	138	J. D. Luther.
May 31	2.59	253	Do.

The location of the Chittenango station is shown on the Chittenango sheet of the Topographic Atlas of the Geological Survey. The gaging station is one-half mile above the State Dam, diverting water for the supply of the summit level of Erie Canal. The records kept show the amount of water supply available for canal purposes. The gaging station at Bridgeport [a] is located below this feeder. The records for the two stations are not comparable during the season of canal navigation.

The flow of Chittenango Creek is regulated by storage in Cazenovia Lake and Erieville reservoir.[b]

ERIEVILLE RESERVOIR.

Tributary watershed	square miles	5.4
Storage capacity	cubic feet	318,424,000
Water surface	acres	340

CAZENOVIA LAKE.

Tributary watershed	square miles	8.7
Storage capacity	cubic feet	206,997,000
Water surface	square miles	1.7

From Chittenango Falls to Chittenango village, a distance of 5 miles, the stream falls from elevation 860 feet above tide to elevation 420. From the foot of Chittenango Falls to Chittenango village the stream flows through a deep, narrow valley, where several water powers have at one time been in use, now mostly abandoned.

The accompanying table shows the mean daily stage of the stream.

A freshet December 15, 1901, raised the water to elevation 7 feet on the gage board.

Drainage area of Chittenango Creek.

Location.	Square miles.
Chittenango gaging station	[c] 77
Bridgeport gaging station	307
Mouth of stream	309

[a] Described on page 112.

[b] Report on New York State Barge Canal Survey, p. 663.

[c] Including Chenango River area made tributary to feed Erieville reservoir.

Daily gage height, in feet, of Chittenango Creek, at Chittenango, N. Y., for 1901.

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1		2.6	1.9	1.75	1.95	1.77	1.8	1.92
2		2.8	1.9	1.75	1.95	1.77	1.8	2.02
3		2.47	1.85	1.8	1.85	1.77	1.8	2.4
4		2.35	1.85	1.8	1.77	1.77	1.82	1.8
5		2.3	2.0	1.8	1.8	1.77	1.85	1.85
6		2.22	2.1	1.82	1.8	1.77	1.82	1.85
7		2.85	2.05	1.9	1.72	1.75	1.85	1.85
8		2.62	1.9	1.87	1.7	1.77	1.85	1.95
9		2.45	1.9	1.82	1.7	1.77	1.87	3.35
10		2.25	1.9	1.85	1.8	1.77	1.87	2.4
11		2.15	1.9	1.75	1.7	1.77	1.8	2.27
12		2.17	1.9	1.9	1.77	1.77	2.05	2.22
13		2.1	1.8	1.9	1.85	1.77	2.0	2.22
14		2.05	1.8	1.9	1.77	1.77	1.8	2.67
15		2.0	1.75	1.9	1.75	1.77	1.8	4.65
16		2.0	1.8	1.85	1.75	1.77	2.0	3.8
17		2.0	1.85	1.87	1.8	1.77	1.8	3.4
18		1.95	1.8	1.8	1.77	1.8	1.8	3.3
19		1.95	1.8	1.85	1.82	1.82	1.8	3.0
20		2.72	1.8	1.9	1.77	1.8	1.8	2.45
21		2.97	1.8	1.9	1.82	1.77	1.8	2.4
22	2.0	2.5	1.8	1.9	1.77	1.77	1.8	2.05
23	2.42	2.85	1.8	1.9	1.77	1.82	1.8	2.0
24	2.15	2.4	1.8	1.92	1.77	1.85	1.87	2.0
25	2.1	2.2	1.82	1.8	1.77	1.85	1.87	2.0
26	2.12	2.2	1.8	1.85	1.77	1.85	1.95	2.0
27	2.1	2.1	1.75	1.85	1.75	1.85	1.87	2.0
28	2.25	2.0	1.7	1.85	1.75	1.82	2.0	2.0
29	2.47	2.0	1.7	1.85	1.75	1.82	1.9	2.2
30	2.65	1.9	1.8	1.87	1.77	1.8	1.9	2.2
31	2.6		1.82	1.9		1.8		2.1

Principal water powers on Chittenango Creek.

No. of dam.	Location.	Available head.	Description.
		Feet.	
1	Bridgeport	6	Snyder Brothers' gristmill; wheels rated 115 H. P.
1	do	6 to 8	Snyder Brothers' sawmill; wheels rated about 20 H. P.
2	Chittenango	5	State canal feeder dam.
3	do	8	Walrath's dam; abandoned iron works.
4	do	14	Chittenango Roller Mills; rated 57 H. P.
4	do	14	Chittenango Cotton Mill; abandoned; owns one-half power at dam.
5	do	8	Abandoned distillery.
6	Chittenango Springs	6 to 8	Nesbet's sawmill.
7	Above Chittenango Springs	6 to 8	Marl lime and sawmill.
8	Chittenango Falls	120	Undeveloped.
9	do	10 to 12	Abandoned repair shop.
10	Cazenovia	10	Bentley's dam, gristmill

SKANEATELES LAKE OUTLET.

Skaneateles Lake is fifth in size of the Finger Lakes tributary to Seneca River. Its run-off is of special interest as illustrating the effect of lake storage on the regimen of flow of that stream. The lake lies in a deep, narrow valley conducive to rapid run-off, so that the water level of the lake fluctuates frequently. Owing to extensive lake storage the variations in the outflow are very moderate. The

lake and its watershed are shown on the Skaneateles sheet of the United States Geological Survey. The watershed areas are as follows:

Drainage area of Skaneateles Lakes.

	Square miles.
Land surface above State dam at Skaneateles	60.25
Water surface of lake at Skaneateles	12.75
Total drainage area above foot of lake	73
Total area above Willowglen weir	74.25
Total area above Erie Canal at Jordan	93

The elevation of Skaneateles Lake is 867 feet above mean tide, and that of the outlet at Erie Canal crossing, near Jordan, about 400 feet. The intervening fall of 467 feet is largely taken up by water powers situated at 17 dams on the outlet in the intervening length of 12 miles. The power is chiefly used for paper, woolen, flour, and furniture manufacturing.

The dam at the foot of the lake was originally constructed by the State of New York in 1844. In 1893 the masonry dam at the foot of the lake was rebuilt by the Syracuse water board, and since July 1, 1894, the lake has been used as the storage reservoir for the municipal supply of the city of Syracuse, the water being taken a distance of 19¼ miles through a 30-inch cast-iron conduit.

A record of the elevation of water in Skaneateles Lake reservoir has been kept each week since January 1, 1878, by gate keepers of New York State canals. The results of this record may be found in the Annual Report of the Superintendent of Public Works on Canals, for 1899, pages 156–159.

In connection with condemnation proceedings for the acquisition of water rights on Skaneateles outlet by the city of Syracuse, a number of gagings of the outflow from the lake were made, some of the results of which have been reduced to second-feet and are given below.[a]

Mean daily flow, in second-feet, at Skaneateles Lake dam, Skaneateles, N. Y., 1890.

[Drainage area, 73 square miles.]

Day.	Sept.	Oct.	Nov.	Dec.	Day.	Sept.	Oct.	Nov.	Dec.
1		108.8	102.1	121.9	18		97.3	117.8	112.8
2		108.8	18.9	121.2	19		101.5	114.8	114.2
3		107.8	101.7	120.9	20		98.9	116.7	112.1
4		106.9	105.1	122.6	21		97.9	114.8	114.7
5		105.5	101.5	121.1	22		98.3	113.6	112.4
6		105.1	99.9	119.4	23		101.7	113.3	107.7
7		104.0	98.6		24		104.6	117.0	105.8
8		101.7	101.7	116.8	25		102.9	117.2	
9		102.5	101.4	117.3	26	126.8	99.9	116.7	107.8
10		100.1	98.3	121.4	27	119.8	100.4	106.2	108.2
11		96.1	99.4	118.4	28	117.8	103.8	122.6	107.8
12		96.6	101.9	116.7	29	112.7	101.9	122.5	105.8
13		94.8	105.7	116.3	30	112.1	101.1	120.6	107.7
14		94.2	112.1	114.1	31		102.9		107.3
15		92.8	115.5	94.2					
16		93.0	118.4	109.1	Mean	117.8	100.88	107.5	113.4
17		95.5	118.3						

[a] Abstracted from Proceedings and Evidence before Commissioners of Appraisal, Supreme Court, Appellate Division, Fourth Department City of Syracuse *v.* Richard M. Stacey et al., Vols. I-X, inclusive.

Mean daily flow, in second-feet, at Skaneateles Lake dam, Skaneateles, N. Y., 1891.

[Drainage area, 73 square miles.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.
1	108.0	113.5	.....	235.6	120.6	.....	.....
2	107.6	112.2	124.6	235.6	122.7	.....	102.3
3	102.7	117.6	139.5	220.1	119.8	.....	82.3
4	103.2	117.2	143.8	215.5	116.3	.....	80.9
5	102.7	118.3	143.8	209.3	112.8	94.2	80.9
6	102.7	98.1	139.2	204.6	.....	93.6	78.4
7	102.1	112.7	139.2	201.5	.....	.....	80.4
8	101.9	114.2	139.2	196.8	.....	82.7	80.4
9	102.1	117.9	139.2	189.1	.....	99.9	79.9
10	101.8	103.4	139.2	199.9	.....	96.7	82.5
11	101.9	116.6	159.6	215.5	.....	95.2	88.5
12	102.6	117.3	167.4	.....	.....	95.5	.....
13	103.8	95.0	182.9	196.8	.....	92.7	87.7
14	104.5	98.3	195.3	190.6	.....	92.1	86.9
15	103.5	117.9	.....	195.3	.....	91.6	93.7
16	95.5	119.5	189.1	195.3	.....	87.4	92.5
17	89.1	.....	186.0	193.7	.....	87.3	77.5
18	104.3	87.7	182.9	192.2	.....	96.6	92.4
19	90.9	94.8	176.7	.....	.....	107.7	88.9
20	93.0	112.5	181.4	186.0	.....	104.8	89.4
21	92.7	.....	176.7	179.8	.....	104.0	90.5
22	108.8	122.4	.....	179.8	.....	104.5	90.7
23	106.5	124.0	.....	170.5	.....	103.1	91.9
24	107.3	121.1	.....	167.4	.....	104.2	90.9
25	107.7	128.0	258.8	164.3	.....	102.6	91.3
26	108.9	132.7	251.1	.....	.....	101.7	.....
27	106.8	135.0	248.0	131.3	.....	90.9	89.7
28	105.5	145.8	240.1	125.4	.....	90.8	104.3
29	105.4	.....	234.1	124.6	.....	89.9	124.1
30	108.3	.....	232.5	122.1	.....	100.4	150.4
31	110.9	.....	240.1	.....	.....	.....	148.3
Mean	102.9	115.2	182.7	186.6	116.4	96.4	94.9

Mean daily flow, in second-feet, of Skaneateles outlet at Stotts weir, Willowglen, N. Y., for 1892.

[Drainage area, 74 square miles.]

Day.	Aug.	Sept.	Oct.	Nov.	Dec.	Day.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	98.6	97.9	86.2	88.4	18	104.0	.....	96.4	80.4	.....
2	.....	100.9	.....	78.4	87.6	19	119.5	107.7	106.9	92.7	81.9
3	.....	95.6	102.5	78.4	82.6	20	103.2	103.2	95.6	.....	81.2
4	.....	.....	109.3	91.1	.....	21	.....	104.0	94.8	88.4	81.2
5	.....	99.4	107.7	88.4	77.0	22	121.1	100.1	94.1	85.6	80.4
6	.....	94.1	103.2	.....	74.2	23	120.3	104.0	.....	88.4	81.2
7	.....	94.8	102.5	85.6	73.6	24	121.1	106.9	91.1	92.7	81.2
8	.....	103.2	98.3	86.2	95.6	25	146.6	.....	90.5	89.7	.....
9	.....	102.5	.....	84.8	88.4	26	99.4	105.4	89.1	85.6	.....
10	.....	100.9	97.9	85.6	85.6	27	98.6	105.4	96.4	.....	81.2
11	.....	.....	94.8	86.2	.....	28	.....	97.9	88.4	89.1	80.4
12	.....	97.9	.....	82.6	82.6	29	96.4	98.6	88.4	86.9	78.4
13	.....	97.9	101.7	.....	81.8	30	100.1	101.7	94.8	85.6	77.8
14	.....	96.4	100.9	78.4	84.0	31	98.6	.....	.....	.....	77.0
15	.....	110.1	101.7	77.0	85.6						
16	104.0	111.6	.....	81.2	84.8	Mean	109.7	101.9	97.7	85.2	82.1
17	103.2	110.8	99.4	79.8	82.6						

Mean daily flow, in second-feet, of Skaneateles outlet at Stotts weir, Willowglen, N. Y., for 1897.

[Drainage area, 74 square miles.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Sept.
1	.....	67.6	77.0	88.4	100.1	241.8	156.5	.....
2	79.8	67.6	77.8	.....	98.6	224.7		
3	82.6	69.6	77.0	89.1	97.0	221.6	153.6	
4	80.4	68.4	76.4	88.4	187.5	.....	153.6	.....
5	78.4	.....	.....	87.6	254.2	220.4	151.7	.....
6	76.4	71.6	75.6	88.4	254.2	195.3	150.0	
7	75.6	78.4	74.2	89.7		179.8	148.3	
8	.....	76.4	73.0	89.7	254.2	128.3	164.3	
9	71.6	74.2	81.8	.....	234.1	123.4		
10	68.9	72.2	79.8	89.7	234.1	121.8	161.3	
11	69.6	70.9	77.0	89.1	234.1		164.3	119.6
12	68.9	.....	.....	85.6	230.9	118.7	163.3	112.5
13	69.9	77.0	75.0	83.4	227.8	153.6	164.3	117.5
14	67.6	78.4	75.6	88.4		151.7	164.3	117.2
15	.....	76.4	74.2	91.1	224.7	150.0	162.7	120.1
16	63.7	74.2	75.0	.....	221.6	148.3	.....	119.6
17	61.2	75.0	77.0	94.1	230.9	146.4	165.8	
18	63.7	75.6	78.4	100.1	234.1		164.3	120.6
19	61.2	.....	.....	101.7	246.5	144.4	161.2	115.0
20	58.6	75.6	84.2	100.1	244.9	144.7	161.2	.....
21	56.1		81.8	101.7	.....	144.7	159.5	.....
22	.....	73.0	85.6	100.1	237.2	145.4	155.0	
23		77.0	86.9	.....	246.5	148.2		
24	66.3	77.8	88.4	103.1	252.6	146.6	151.7	
25	64.3	77.0	88.4	98.6	249.5	.....	148.3	
26	63.7	.....	.....	97.0	246.5	143.4	151.7	
27	58.6	78.4	86.9	95.6	244.9	142.1	151.7	
28	57.4	77.0	85.6	94.1		143.5	155.9	
29	.....	.....	84.0	92.7	243.4	145.1	156.1	
30	68.9	.....	84.8	.....	241.8	145.1		
31	68.4	.....	86.9	.....	241.8			
Mean	68.0	74.7	80.2	93.1	222.7	158.4	155.3	118.5

Mean daily flow, in second-feet, of Skaneateles outlet at Stotts weir, Willowglen, N. Y., for 1897.

[Drainage area, 74 square miles.]

Day.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	.....	54.0	37.5	78.0	81.0	72.2
2	.....	15.4	56.4	66.8	78.0	78.0	78.0
3	.....	19.0	59.0	66.8	78.0	84.0	
4	.....	17.2	59.0	65.5	81.0	84.0	
5	.....	15.4	54.0	66.8	81.0	84.0	
6	7.5	15.4	56.9	81.0	81.0	84.0	
7	5.7	17.2	56.0	102.0	78.0	84.0	
8	4.5	.....	54.0	102.0	78.0	84.0	
9	4.0	39.7	59.0	105.0	81.0	81.0	
10	.....	42.0	54.0	81.0	87.0	81.0	
11	3.5	35.2	56.0	78.0	87.0	78.0	
12	4.0	31.0	54.0	78.0	81.0	78.0	
13	4.5	29.0	54.0	81.0	87.0	78.0	
14	3.5	31.0	56.0	84.0	84.0	78.0	
15	3.5	.....	56.0	81.0	87.0	78.0	
16	3.5	27.0	54.0	81.0	87.0	78.0	
17	.....	25.0	54.0	81.0	87.0	81.0	
18	2.5	25.0	56.0	84.0	84.0	81.0	
19	10.0	23.0	64.2	86.8	81.0	78.0	
20	2.0	23.0	61.6	86.8	81.0	78.0	
21	23.0	27.0	59.0	86.8	81.0	78.0	
22	11.0	.....	56.0	84.0	78.0	78.0	
23	2.6	27.0	54.0	81.0	81.0	78.0	
24	.....	31.0	61.6	78.0	84.0	78.0	
25	6.8	37.6	64.2	78.0	84.0	78.0	
26	21.0	72.2	61.6	78.0	81.0	78.0	
27	17.2	69.7	64.2	78.0	75.2	78.0	
28	27.0	59.0	61.6	75.1	75.2	75.2	
29	29.0	.....	61.6	72.2	75.2	75.2	
30	25.0	56.6	59.0	72.2	75.2	75.2	
31	.....	51.0	56.4		78.0		
Mean	10.1	33.2	56.0	79.3	81.2	79.1	[illegible]

The records included are as follows:

At State dam, at foot of lake, October 26, 1890, to July 31, 1891.
At Stotts farm weir, August 16, 1892, to September 19, 1893.
At Stotts farm weir, June 6, 1894, to December 2, 1894.
At Jordan, September 26, 1890, to October 28, 1891.
At Jordan, August 16, 1892, to November 30, 1892.
At old Willowglen weir, March 10 to July 13, 1895.
At new Willowglen weir, July 14, 1895, to date.

The first table shows the estimated discharge through the dam at the foot of the lake for the period from September 26, 1890, to February 27, 1892, inclusive. At the time these measurements were made the dam had a spillway 48 feet in length, with a flat and nearly horizontal crest 4.5 feet in width. The crest was obstructed by supports for a footbridge, by which the overflow was divided into a number of shorter sections. There were also six rectangular gateways through the dam having their sills at a uniform elevation of 9.33 feet below the crest line. Four gateways were 4 feet wide and two were 3.5 feet in width. Sliding wooden sluice gates were used, which were capable of being raised 4 or 5 feet. No allowance for leakage has been made, and the results are considered as somewhat roughly approximate.

The second series of tables shows the results of measurements of discharge of Skaneateles Lake at the Stotts farm weir, situated 6,000 feet north of the foot of the lake and receiving drainage from 1.25 square miles tributary to the outlet, in addition to the drainage area of the lake itself. The weir had a clear crest 30 feet in length and seven-eighths inches in breadth. The flow has been computed by means of the Francis formula for a sharp-crested weir. The crest was somewhat irregular, and the resulting calculated discharge is considered as roughly approximate only.

In order to determine the run-off to the watershed contributed by the drainage area of the outlet itself, from the foot of the lake to Jordan, the following series of gagings were made, covering the period from September 26, 1890, to November 30, 1892. The drainage area of 93 square miles at Jordan includes 73 square miles the run-off from which is subject to lake storage, and 20 square miles which drains directly into the outlet. The measurements at Jordan were made by means of tube floats by timing the interval required for their passage through a section of the stream channel 100 feet in length.

Beginning March 6, 1895, a daily record of the depth of water flowing over a standard sharp-crested gaging weir has been kept by the water department of Syracuse. The weir is located at Willowglen, 1½ miles below the foot of the lake. It has complete contractions at the ends, the length of crest being as follows:

	Feet.
March 6 to July 13, 1895, inclusive	29.5
July 14, 1895, to date	27.0

The discharge over this weir has been calculated by means of the Francis formula, with proper allowances for end contractions and

velocity of approach. Four current-meter measurements of the discharge of Skaneateles outlet were made during the present season.

Measurements of Skaneateles outlet at Willowglen, N. Y.

Date.	Depth on weir.	Calculated flow over weir.	Dischage by current meter.	
			Second feet.	Per cent of weir discharge.
1901.	*Inches.*	*Sec. feet.*		
July 20 [a]	13.75	113.0	117.8	104.2
August 29 [b]	11.97	90.8	92.0	101.3
Do. [b]	12.02	91.2	88.0	96.5
Do. [b]	12.02	91.2	92.0	101.3

[a] R. E. Horton, hydrographer. [b] E. C. Murphy, hydrographer.

The crest is level and the depth of overflow is measured from a stake 5.2 feet upstream from the weir. The channel above is straight and has an average depth of about 1.5 feet below the weir crest. The velocity of approach varies from zero to 2 feet per second. As stated above, water has been diverted from Skaneateles Lake, beginning July 1, 1894.

Mean daily flow, in second-feet, of Skaneateles outlet at Jordan, N. Y., for 1890.

[Drainage area, 93 square miles.]

Day.	Sept.	Oct.	Nov.	Dec.	Day.	Sept.	Oct.	Nov.	Dec.
1		154.2	146.3	162.7	18		141.1		161.2
2		159.6	116.1	175.2	19		168.9	161.2	141.7
3		144.5	159.6	167.4	20		164.3	179.8	
4		147.4	152.7	152.5	21		165.8	168.9	
5		143.7	146.8	167.4	22		153.6	158.1	179.8
6		158.1	142.9	168.9	23		151.7	133.1	165.8
7		159.6	133.5		24		209.3		147.8
8		155.0	147.8	128.4	25		179.8	175.2	
9		164.3	151.4	178.3	26	170.5	123.2	173.6	
10		150.9	158.1	158.1	27	162.8	147.1	162.7	
11		155.0	143.5	148.9	28	154.5	153.7	156.5	
12		146.6	161.2	149.2	29	150.0	158.1	158.1	
13		151.6	158.1	161.2	30	145.2	135.2	161.2	
14		156.5	161.2	159.6	31		155.0		
15		137.5	171.0	176.7					
16		137.9	156.5	181.4	Mean	156.6	153.9	155.2	161.5
17		149.7	152.2						

Mean daily flow, in second-feet, of Skaneateles outlet at Jordan, N. Y., for 1891.

[Drainage area, 93 square miles.]

Day.	June.	July.	Aug.	Sept.	Oct.	Day.	June.	July.	Aug.	Sept.	Oct.
1			189.1			18	119.5	110.1	165.8	149.8	
2		139.2	154.5			19	130.2	123.7	156.5	141.5	154.1
3		91.9	153.7			20	130.8	126.5	158.1	140.1	156.5
4		106.6	123.7	139.5		21	130.0	121.9	138.8	148.0	164.3
5		108.9	144.3	141.3	148.2	22	143.9	112.2	144.6	139.8	155.0
6		114.7	150.4			23	133.5	97.0	159.6	146.2	152.2
7		108.5	182.9	139.2	154.8	24	132.2	102.6	146.2	141.1	149.8
8		111.1	182.9		156.5	25	130.9	98.4	132.1	141.5	135.6
9		120.4		143.1	153.7	26	128.8		128.2	151.4	
10		74.8			150.5	27	134.5	100.6	123.2		139.3
11	129.1	118.8	168.9	151.3	139.6	28	116.8	113.2			140.3
12	127.8		172.1	162.7	145.8	29	119.5		123.4		
13	121.2	118.3	172.0	150.4	146.0	30	137.3				
14	119.5	117.0	164.3	153.1		31		187.5	118.1		
15	126.0	130.8	158.1	153.3							
16	125.2	122.3	152.7	149.6	139.9	Mean	127.8	115.3	153.1	146.6	148.7
17	119.6	120.7	159.6	151.4	143.4						

Mean daily flow, in second-feet, of Skaneateles outlet at Jordan, N. Y., for 1892.

[Drainage area, 93 square miles.]

Day.	Aug.	Sept.	Oct.	Nov.	Day.	Aug.	Sept.	Oct.	Nov.
1		108.6	117.3		18	118.3		115.8	114.8
2		98.9			19	113.3	124.5	110.9	136.5
3		105.7	119.6	117.3	20	123.1	122.5	113.5	
4			128.8	118.3	21		117.5		126.9
5		110.4	150.8	115.8	22	144.5			119.9
6			132.5		23	134.2	117.2		109.4
7			124.3	113.9	24	145.1	126.5		113.7
8			121.6		25	170.5			114.5
9		123.7			26	143.8	140.9		107.8
10		103.4	119.6	108.6	27	122.3	129.4		
11			111.9		28		123.5		119.9
12		111.1		109.7	29	117.8	110.5		113.9
13		105.8	118.8		30	112.1	113.5		108.9
14			117.9	112.2	31	113.3			
15			116.1	101.7					
16	122.5	115.6			Mean	128.5	116.5	121.2	114.6
17	119.5	122.1	119.2	109.4					

The following tables represent the mean daily flow in the outlet, not including diversion. The table represents the actual volume of water flowing down the outlet channel. To obtain the actual run-off from the watershed, the amount of diversion for municipal supply should be added. This has been done in the following summary, showing the actual run-off in inches on the watershed deduced from all the available records. The flow in the conduit leading from Skaneateles dam to Syracuse is determined by measuring the effective head and area of discharge in the gatehouse at Skaneateles village. The gates are 4 in number. They are 2.5 feet wide and 4.5 feet high. The flow is regulated by gate No. 3, and the discharge is calculated for each day from the formula for orifices. The coefficient used is stated to be 0.62.

The recorded depths on Willowglen weir, together with the estimated monthly water consumption by the city of Syracuse, have been furnished by John H. Moffitt, superintendent Syracuse water department.

Mean monthly run-off of Skaneateles outlet at Stotts weir, Willowglen, N. Y.

[Drainage area, 74 square miles.]

Month	Mean monthly flow in second-feet.			Run-off in second-feet per square mile.			Run-off in inches on drainage area.		
	1892.	1893.	1894.	1892.	1893.	1894.	1892.	1893.	1894.
January		68.0			0.92			1.06	
February		74.7			1.01			1.05	
March		80.2			1.08			1.24	
April		93.1			1.26			1.41	
May		222.7			3.01			3.46	
June		158.1	10.1		2.13	0.14		2.39	0.16
July		157.3	38.2		2.12	.45		2.44	.52
August	109.7		56.0	1.46		.76	1.68		.87
September	101.9	117.5	79.3	1.38	1.59	1.07	1.55	1.78	1.19
October	97.7		81.2	1.32		1.09	1.52		1.25
November	85.2		79.4	1.15		1.07	1.29		1.19
December	82.1		75.1	1.11		1.01	1.28		1.16

Mean daily flow, in second-feet, of Skaneateles outlet at Willowglen weir for 1895.

[Drainage area, 74 square miles.

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	103.4	112.8	85.4	77.0	100.3	100.3	95.7	100.3	94.2
2	.....	103.4	109.7	85.4	82.6	97.2	100.3	97.2	97.2	97.2
3	.....	103.4	109.7	85.4	82.6	97.2	100.3	95.7	97.2	97.2
4	.....	103.4	156.6	85.4	82.6	97.2	100.3	95.7	97.2	97.2
5	.....	103.4	160.2	85.4	85.4	100.3	100.3	95.7	97.2	94.2
6	.....	103.4	156.6	91.4	85.4	100.3	97.2	95.7	97.2	85.5
7	.....	106.5	150.0	85.4	85.4	100.3	97.2	95.7	97.2	80.0
8	.....	103.4	150.0	85.4	85.4	100.3	100.3	95.7	100.3	81.4
9	.....	109.8	109.8	85.4	85.4	100.3	97.2	97.2	106.6	81.4
10	2.8	136.0	109.8	85.4	85.4	100.3	97.2	95.7	100.3	80.0
11	43.7	149.8	109.8	85.4	85.4	98.8	97.2	95.7	100.3	80.0
12	66.0	186.0	112.8	85.4	85.4	100.3	97.2	97.2	100.3	80.0
13	91.4	186.0	112.8	85.4	88.4	100.3	97.2	100.3	94.2	80.0
14	91.4	186.0	122.4	85.4	81.4	97.2	95.7	97.2	94.2	80.0
15	85.4	171.0	129.0	85.4	88.3	97.2	95.7	97.2	94.2	80.0
16	91.4	171.0	122.4	85.4	88.3	97.2	95.7	95.7	94.2	80.0
17	91.4	167.4	122.4	85.4	88.3	97.2	95.7	97.2	94.2	80.0
18	88.4	167.4	122.4	85.4	88.3	97.2	95.7	100.3	94.2	80.0
19	91.4	164.0	97.6	85.4	91.2	95.7	95.7	100.3	94.2	81.4
20	100.2	164.0	91.4	82.6	94.2	95.7	100.3	100.3	97.2	80.0
21	100.2	164.0	85.4	82.6	94.2	95.7	95.7	100.3	97.2	80.0
22	97.6	167.4	85.4	85.4	94.2	97.2	95.7	100.3	97.2	82.8
23	97.6	167.4	85.4	85.4	94.2	97.2	95.7	100.3	97.2	82.8
24	97.6	164.0	85.4	82.6	94.2	97.2	95.7	100.3	100.3	82.8
25	100.2	164.0	85.4	79.8	94.2	97.2	95.7	106.6	100.3	82.8
26	100.2	164.0	85.4	79.8	94.2	95.7	95.7	106.6	100.3	82.8
27	94.5	136.0	103.4	79.8	94.2	95.7	95.7	106.6	97.2	85.5
28	94.5	122.4	85.4	79.8	100.3	95.7	95.7	106.6	94.2	85.5
29	97.6	119.2	91.4	79.8	100.3	97.2	97.2	106.6	94.2	85.5
30	94.5	116.0	85.4	77.0	103.4	97.2	97.2	100.3	94.2	82.8
31	100.4	.....	85.4	.....	100.3	97.2	....	100.3	....	82.8
Mean	87.2	145.7	110.7	84.0	89.7	97.8	97.2	99.2	97.3	84.1

Mean daily flow, in second-feet, of Skaneateles outlet at Willowglen weir for 1896.

[Drainage area, 74 square miles.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	82.6	80.0	91.2	103.4	109.8	78.7	77.3	77.3	82.8	85.5	77.3	73.4
2	80.0	80.0	91.2	91.2	109.8	78.7	77.3	78.7	82.8	85.5	77.3	73.4
3	80.0	80.0	82.8	82.8	91.2	78.7	77.3	78.7	82.8	85.5	77.3	73.4
4	80.0	80.0	82.8	82.8	85.5	78.7	77.3	78.7	82.8	77.3	77.3	73.4
5	80.0	80.0	82.8	85.5	85.5	78.7	77.3	78.7	82.8	77.3	77.3	69.6
6	80.0	82.8	82.8	82.8	85.5	78.7	77.3	78.7	82.8	77.3	77.3	70.9
7	80.0	82.8	109.8	82.8	91.2	89.8	77.3	78.7	82.8	77.3	76.0	70.9
8	80.0	82.8	91.2	82.8	91.2	89.8	77.3	78.7	82.8	84.1	76.0	74.7
9	80.0	85.5	82.8	80.0	92.2	89.8	77.3	78.7	82.8	80.0	76.0	74.7
10	78.7	82.8	82.8	80.0	86.9	88.3	77.3	78.7	82.8	77.3	76.0	72.2
11	78.7	80.0	82.8	80.0	86.9	88.3	77.3	78.7	82.8	77.3	76.0	69.6
12	80.0	80.0	82.8	80.0	86.9	88.3	76.0	78.7	82.8	77.3	74.7	69.6
13	80.0	80.0	82.8	82.8	80.0	88.3	76.0	78.7	82.8	80.0	74.7	69.6
14	80.0	85.5	82.8	80.0	80.0	88.3	76.0	78.7	82.8	82.8	76.0	69.6
15	80.0	82.8	85.5	81.4	80.0	88.3	76.0	78.7	82.8	82.8	74.7	68.4
16	80.0	80.0	85.5	81.4	80.0	88.3	76.0	78.7	81.4	81.4	74.7	67.1
17	80.0	82.8	85.5	81.4	78.7	88.3	76.0	78.7	81.4	80.0	74.7	67.1
18	80.0	82.8	85.5	82.8	78.7	81.4	76.0	80.0	82.8	80.0	74.7	67.1
19	82.8	82.8	85.5	81.4	78.7	81.4	74.7	80.0	85.5	78.7	74.7	65.9
20	80.0	82.8	85.5	81.4	78.7	81.4	76.0	80.0	85.5	78.7	74.4	65.9
21	80.0	80.0	85.5	82.8	78.7	82.8	74.7	80.0	85.5	78.7	74.7	65.9
22	80.0	80.0	82.8	82.8	78.7	82.8	74.7	80.0	85.5	78.7	76.0	65.9
23	77.3	82.8	82.8	81.4	78.7	80.0	74.7	78.7	81.4	78.7	77.3	65.9
24	80.0	80.0	82.8	81.4	78.7	80.0	74.7	78.7	81.4	77.3	80.6	65.9
25	80.0	80.0	82.8	81.4	78.7	80.0	74.7	78.7	85.5	77.3	80.0	65.9
26	80.0	80.0	88.3	80.0	80.0	78.7	74.7	78.7	85.5	77.3	74.7	65.9
27	80.0	80.0	80.0	80.0	80.0	78.7	74.7	78.7	85.5	77.3	77.3	65.9
28	80.0	85.5	77.3	78.7	80.0	78.7	74.7	78.7	85.5	77.3	80.0	65.9
29	80.0	109.8	85.5	78.7	80.0	80.0	78.6	78.7	85.5	77.3	74.7	64.6
30	80.0	.....	100.3	109.8	80.0	78.7	78.6	78.7	85.5	77.3	73.4	64.6
31	80.0	.....	100.3	.....	78.7	.....	77.3	78.7	....	77.3	....	65.9
Mean	80.0	82.5	89.1	83.4	84.3	83.1	76.3	78.8	83.5	79.4	76.2	68.6

Mean daily flow, in second-feet, of Skaneateles outlet at Willowglen weir for 1897.

[Drainage area, 74 square miles.]

Day.	Jan.	Feb.	Mar.	Apr	May.	June	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	65.8	60.9	62.1	5.80	2.55	72.2	77.3	74.7	80.0	74.7	88.3	65.9
2	65.8	59.7	60.9	5.80	3.00	72.2	76.0	85.5	80.0	74.7	88.3	65.9
3	65.8	59.7	62.1	5.80	3.00	74.7	76.0	85.5	80.0	74.7	91.2	65.9
4	65.8	59.7	64.6	5.80	5.20	74.7	74.7	85.5	80.0	74.7	89.8	65.9
5	70.9	59.7	64.6	5.80	3.00	74.7	74.7	97.2	80.0	74.7	89.8	72.2
6	67.1	59.7	67.1	6.40	2.55	73.7	74.7	129.2	80.0	74.7	89.8	72.2
7	67.1	59.7	67.1	8.80	41.7	72.2	74.7	189.2	80.0	77.3	89.8	69.6
8	64.6	59.7	64.6	5.80	72.2	72.2	74.7	189.2	78.7	77.3	89.8	67.1
9	64.6	60.9	68.4	7.60	69.6	72.2	74.7	132.5	77.3	85.5	89.8	67.1
10	64.6	50.9	69.6	8.80	2.55	74.7	74.7	97.2	77.3	91.2	100.3	67.1
11	64.6	60.9	67.1	6.40	69.6	72.2	74.7	109.8	77.3	91.2	100.3	67.1
12	65.8	60.9	67.1	6.40	74.7	72.2	74.7	135.8	76.0	91.2	100.3	67.1
13	65.8	59.7	64.6	5.80	94.2	72.2	74.7	135.8	76.0	91.2	85.5	67.1
14	65.8	60.9	64.6	5.80	97.2	72.2	74.7	135.8	76.0	91.2	85.5	67.1
15	65.8	60.9	64.6	5.20	97.2	72.2	74.7	135.8	76.0	91.2	85.5	69.6
16	65.8	60.9	64.6	6.40	97.2	72.2	76.0	135.8	76.0	91.2	85.5	70.9
17	65.8	60.9	64.6	5.80	97.2	72.2	76.0	135.8	76.0	91.2	85.5	69.6
18	65.8	62.1	64.6	5.80	69.6	72.2	74.7	135.8	76.0	91.2	86.9	68.4
19	65.8	62.1	64.6	5.80	69.6	72.2	74.7	135.8	76.0	91.2	72.3	69.6
20	64.6	62.1	80.0	5.20	82.6	72.2	76.0	135.8	76.0	91.2	72.3	68.4
21	65.8	62.1	74.7	5.20	82.6	72.2	76.0	129.2	77.3	91.2	69.6	67.1
22	64.6	62.1	74.7	5.20	80.0	72.2	76.0	129.2	76.0	91.2	65.9	67.1
23	63.4	63.4	64.6	5.20	82.6	80.0	80.0	129.2	76.0	91.2	65.9	67.1
24	64.6	62.1	67.1	4.10	82.6	80.0	77.3	124.3	77.3	91.2	65.9	67.1
25	64.6	62.1	14.3	4.10	80.0	80.0	77.3	124.3	76.0	91.2	65.9	67.1
26	59.7	62.1	8.8	5.20	80.0	74.7	77.3	124.3	76.0	91.2	65.9	67.1
27	59.7	62.1	6.4	3.55	80.0	74.7	76.0	144.3	76.0	89.8	70.9	67.1
28	59.7	60.9	6.4	3.55	77.3	74.7	77.3	144.3	76.0	89.8	72.2	67.1
29	59.7	.....	6.4	3.00	74.7	74.7	74.7	144.3	74.7	89.8	69.6	67.1
30	59.7	.....	6.4	3.00	72.2	77.3	74.7	144.3	74.7	89.8	65.9	67.1
31	60.9	.....	6.4	.....	72.2	.....	74.7	80.0	.....	88.3	.....	67.1
Mean	64.5	61.0	53.3	5.60	61.89	73.8	75.3	126.4	77.1	85.4	81.5	66.8

Mean daily flow, in second-feet, of Skaneateles outlet at Willowglen weir for 1898.

[Drainage area, 74 square miles.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	67.1	64.6	65.9	72.2	80.0	73.4	72.2	72.2	72.2	69.6	68.4	72.2
2	67.1	64.6	65.8	70.9	80.0	73.4	72.2	72.2	72.2	69.6	68.4	69.6
3	65.9	64.6	65.8	69.6	97.2	73.4	72.2	72.2	72.2	69.6	68.4	69.6
4	65.9	64.6	65.8	69.6	82.7	73.4	72.2	72.2	72.2	69.6	68.4	69.6
5	65.9	64.6	65.8	70.9	78.7	73.4	69.6	72.2	72.2	69.6	68.4	74.7
6	67.1	64.6	65.8	72.2	80.0	73.4	69.6	72.2	72.2	69.6	69.6	69.6
7	67.1	64.6	65.8	69.6	68.4	72.2	69.6	72.2	74.7	68.4	69.6	69.6
8	67.1	64.6	67.1	69.6	68.4	72.2	69.6	72.2	77.3	68.4	68.4	69.6
9	67.1	64.6	67.1	69.6	67.1	70.9	69.6	72.2	72.2	68.4	68.4	69.6
10	67.1	67.1	67.1	69.6	67.1	70.9	73.4	72.2	72.2	67.1	91.2	69.6
11	67.1	69.6	67.1	69.6	78.7	70.9	73.4	72.2	72.2	69.6	82.8	69.6
12	67.1	80.0	68.4	69.6	89.8	74.7	73.4	72.2	72.2	69.6	72.2	69.6
13	67.1	74.7	74.7	69.6	80.0	72.2	73.4	72.2	72.2	69.6	72.2	69.6
14	68.4	74.7	69.6	69.6	69.6	70.9	73.4	72.2	72.2	72.2	72.2	69.6
15	68.4	67.1	68.4	69.6	65.8	70.9	74.7	72.2	72.2	74.7	69.6	69.6
16	68.4	64.6	68.4	69.6	65.8	70.9	74.7	72.2	72.2	68.4	69.6	69.6
17	69.6	64.6	68.4	69.6	65.8	70.9	73.4	72.2	72.2	68.4	69.6	72.2
18	69.6	67.1	68.4	69.6	65.8	70.9	73.4	72.2	72.2	68.4	69.6	74.7
19	72.2	67.1	72.2	69.6	65.8	70.9	73.4	72.2	69.6	68.4	72.2	74.7
20	77.3	69.6	74.7	72.2	72.2	70.9	73.4	72.2	69.6	68.4	80.0	76.0
21	78.7	69.6	72.2	72.2	76.0	69.6	73.4	72.2	69.6	74.7	74.7	77.3
22	69.6	68.4	69.6	72.2	76.0	69.6	73.4	72.2	69.6	85.5	74.7	77.3
23	72.2	67.1	74.7	74.7	76.0	69.6	73.4	73.4	69.6	88.3	74.7	77.3
24	69.6	67.1	72.2	82.8	76.0	69.6	73.4	72.2	72.2	85.5	72.2	74.7
25	69.6	67.1	72.2	80.0	74.7	69.6	73.4	72.2	72.2	85.5	72.2	74.7
26	69.6	67.1	70.9	68.4	76.0	69.6	73.4	72.2	72.2	88.3	72.2	73.4
27	69.6	67.1	69.6	68.4	77.3	69.6	73.4	72.2	72.2	88.3	72.2	72.2
28	69.6	67.1	72.2	68.4	74.7	69.6	73.4	72.2	72.2	72.2	69.6	72.2
29	68.4	.....	74.7	67.1	74.7	69.6	73.4	72.2	69.6	68.4	69.6	72.2
30	64.6	.....	74.7	67.1	74.7	72.2	73.4	72.2	69.6	68.4	69.6	74.7
31	64.6	.....	70.9	.....	73.4	.....	73.4	72.2	.....	68.4	.....	73.4
Mean	68.6	67.4	69.5	70.79	74.7	71.3	72.7	72.2	71.8	72.9	72.0	72.2

Mean daily flow, in second-feet, of Skaneateles outlet at Willowglen weir for 1899.

[Drainage area, 74 square miles.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	76.0	72.2	72.2	72.2	72.2	77.3	74.7	69.6	64.6	64.6	64.6	59.7
2	74.7	69.6	77.3	72.2	77.3	80.0	74.7	69.6	64.6	62.1	62.1	59.7
3	80.0	69.6	77.3	72.2	72.2	77.3	72.2	69.6	64.6	60.9	60.9	59.7
4	80.0	67.1	77.3	72.2	67.1	77.3	72.2	69.6	64.6	59.7	62.1	59.7
5	77.3	64.6	77.3	72.2	67.1	77.3	72.2	69.6	64.6	59.7	62.1	59.7
6	74.7	64.6	74.7	74.7	67.1	77.3	72.2	69.6	64.6	59.7	59.7	59.7
7	72.2	64.6	69.6	77.3	67.1	76.0	72.2	69.6	64.6	59.7	59.7	59.7
8	73.4	67.1	64.6	77.3	67.1	74.7	74.7	69.6	64.6	62.1	59.7	59.7
9	73.4	64.6	65.8	80.0	67.1	74.7	77.3	69.6	64.6	62.1	59.7	59.7
10	73.4	64.6	64.6	74.7	67.1	74.7	72.2	69.6	64.6	62.1	59.7	59.7
11	73.4	64.6	67.1	72.2	67.1	76.0	69.6	69.6	64.6	60.9	59.7	59.7
12	74.7	64.6	69.6	85.5	74.7	76.0	69.6	69.6	64.6	60.9	59.7	6.40
13	77.3	64.6	69.6	74.7	69.6	76.0	69.6	67.1	64.6	60.9	59.7	6.40
14	85.5	64.6	64.6	72.2	67.1	77.3	69.6	67.1	64.6	60.9	59.7	6.40
15	88.3	69.6	64.6	72.2	67.1	88.3	69.6	67.1	64.6	62.1	59.7	6.40
16	88.3	69.6	64.6	72.2	72.2	88.3	74.7	67.1	63.4	62.1	59.7	6.40
17	88.3	69.6	64.6	72.2	72.2	85.5	85.5	67.1	63.4	62.1	59.7	6.40
18	74.7	69.6	69.6	72.2	74.7	88.3	88.3	65.9	63.4	62.1	59.7	6.40
19	72.2	69.6	69.6	72.2	74.7	85.5	91.2	65.9	63.4	62.1	59.7	32.0
20	72.2	69.6	72.2	72.2	80.0	85.5	91.2	65.9	63.4	62.1	59.7	8.80
21	72.2	73.4	64.6	70.9	82.8	85.5	91.2	65.9	63.4	59.7	59.7	6.40
22	72.2	74.7	64.6	70.9	72.2	85.5	91.2	67.1	63.4	59.7	59.7	5.20
23	72.2	74.7	69.6	70.9	70.9	77.3	91.2	67.1	63.4	59.7	59.7	5.20
24	72.2	74.7	72.2	70.9	70.9	77.3	91.2	67.1	62.1	59.7	59.7	24.3
25	72.2	74.7	69.6	72.2	72.2	74.7	91.2	67.1	62.1	59.7	59.7	8.80
26	74.7	74.7	69.6	122.7	72.2	74.7	91.2	67.1	64.6	59.7	59.7	8.80
27	74.7	69.6	69.6	94.2	77.3	74.7	91.2	67.1	62.1	59.7	59.7	7.60
28	72.2	69.6	69.6	80.0	80.0	74.7	91.2	67.1	62.1	59.7	59.7	7.60
29	72.2	.....	69.6	70.9	74.7	74.7	69.6	64.6	64.6	59.7	59.7	7.60
30	72.2	.....	72.2	72.2	78.7	74.7	69.6	64.6	64.6	59.7	59.7	7.60
31	72.2	.....	74.7	.....	77.3	.....	69.6	64.6	.....	62.1	.....	7.00
Mean	75.5	68.9	69.7	76.0	72.3	78.9	79.1	67.7	64.1	60.9	60.1	27.0

Mean daily flow, in second-feet, of Skaneateles outlet at Willowglen weir for 1900.

[Drainage area, 74 square miles.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	6.40	24.3	20.7	11.50	6.40	33.0	36.1	69.6	68.4	64.6	85.5	77.3
2	6.40	24.3	17.40	11.50	6.40	33.0	36.1	69.6	68.4	119.4	82.8	77.3
3	6.40	24.3	17.40	11.50	6.40	34.0	36.1	69.6	69.6	119.4	82.8	74.7
4	20.7	24.3	14.30	11.50	5.20	34.0	35.1	69.6	69.6	119.4	82.8	74.7
5	6.40	24.3	14.30	11.50	5.20	34.0	35.1	69.6	70.8	119.4	82.8	88.3
6	8.80	24.3	17.40	11.50	5.20	34.0	35.1	69.6	70.8	119.4	82.8	85.5
7	11.50	30.0	17.40	11.50	5.20	34.0	35.1	69.6	70.8	119.4	82.8	80.0
8	20.7	30.0	17.40	8.80	6.40	34.0	36.1	69.6	70.8	119.4	82.8	77.3
9	82.8	30.0	17.40	8.80	6.40	34.0	36.1	69.6	70.8	91.2	82.8	74.7
10	20.7	30.0	17.40	7.60	6.40	34.0	36.1	69.6	69.6	91.2	82.8	74.7
11	14.30	30.0	11.50	8.80	17.40	32.0	36.1	69.6	69.6	88.3	82.8	36.1
12	8.80	30.0	11.50	8.80	17.40	26.2	36.1	69.6	69.6	85.5	82.8	36.1
13	8.80	30.0	11.50	8.80	20.70	35.1	36.1	69.6	67.1	85.5	80.0	36.1
14	8.80	30.0	11.50	8.80	17.40	35.1	36.1	69.6	67.1	88.3	80.0	36.1
15	10.1	30.0	11.50	8.80	14.30	34.0	36.1	69.6	67.1	88.3	80.0	36.1
16	14.30	30.0	11.50	8.80	14.30	34.0	36.1	69.6	67.1	88.3	78.7	36.1
17	11.50	30.0	11.50	8.80	14.30	36.1	38.3	68.4	67.1	88.3	78.7	36.1
18	14.30	30.0	11.50	8.80	14.30	36.1	38.3	68.4	67.1	88.3	78.7	36.1
19	17.40	30.0	14.30	8.80	15.1	35.1	38.3	69.6	67.1	86.9	78.7	36.1
20	36.10	30.0	20.70	8.80	14.30	35.1	36.1	68.5	67.1	86.9	78.7	37.2
21	20.7	30.0	20.70	8.80	14.30	34.0	36.1	68.5	64.6	85.5	78.7	38.3
22	17.40	30.0	14.30	10.1	35.1	34.0	34.0	68.5	64.6	85.5	78.7	38.3
23	11.50	30.0	11.50	8.80	35.1	34.0	80.0	68.5	64.6	85.5	78.7	40.5
24	11.50	30.0	11.50	8.80	35.1	34.0	69.6	68.5	64.6	85.5	78.7	40.5
25	14.30	30.0	17.40	7.60	35.1	36.1	72.2	68.5	64.6	85.5	80.0	40.5
26	20.7	30.0	11.50	7.60	35.1	36.1	69.6	68.5	64.6	85.5	116.2	37.2
27	17.40	30.0	11.50	7.60	35.1	36.1	69.6	68.5	64.6	85.5	85.5	36.1
28	14.30	30.0	11.50	6.40	34.0	36.1	69.6	68.5	64.6	85.5	85.5	36.1
29	11.50	.....	14.30	6.40	33.0	36.1	69.6	68.5	64.6	85.5	92.7	36.1
30	11.50	.....	14.30	6.40	33.0	36.1	69.6	68.5	64.6	85.5	77.3	36.1
31	11.50	.....	14.30	.....	33.0	.....	69.6	68.5	.....	85.5	.....	36.1
Mean	16.0	28.7	14.5	9.07	18.6	34.2	46.3	69.1	67.4	93.5	82.7	50.4

Mean daily flow, in second-feet, of Skaneateles outlet at Willowglen weir for 1901.

[Drainage area, 74 square miles.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	36.1	32.0	32.0	36.1	135.8	97.2	203.5	97.2	85.5	82.8	103.4	103.4
2	36.1	32.0	32.0	36.1	132.5	129.2	203.5	97.2	85.5	82.8	103.4	122.7
3	36.1	32.0	32.0	54.8	129.2	129.2	203.5	97.2	85.5	82.8	103.4	80.0
4	36.1	32.0	32.0	45.1	142.5	135.8	203.5	97.2	85.5	82.8	103.4	80.0
5	36.1	32.0	32.0	54.8	146.0	142.5	149.5	97.2	85.5	82.8	103.4	80.0
6	36.1	32.0	32.0	59.7	146.0	142.5	149.5	97.2	85.5	82.8	103.4	80.0
7	36.1	32.0	32.0	40.5	132.5	171.2	149.5	97.2	85.5	82.8	103.4	80.0
8	36.1	32.0	32.0	54.8	132.5	171.2	149.5	97.2	82.8	82.8	103.4	80.0
9	40.5	32.0	32.0	49.9	132.5	175.0	149.5	97.2	82.8	82.8	103.4	80.0
10	40.5	32.0	36.1	97.2	135.8	175.0	129.2	97.2	82.8	80.0	103.4	80.0
11	41.7	42.0	54.8	97.2	135.8	175.0	129.2	94.2	82.8	80.0	103.4	80.0
12	49.9	32.0	49.9	97.2	135.8	175.0	129.2	94.2	82.8	80.0	103.4	80.0
13	42.8	32.0	40.5	97.2	129.2	175.0	129.2	94.2	82.8	80.0	103.4	80.0
14	38.3	32.0	40.5	91.2	129.2	175.0	109.8	94.2	82.8	80.0	103.4	103.4
15	36.1	32.0	40.5	91.2	129.2	175.0	109.8	94.2	82.8	80.0	103.4	106.6
16	36.1	32.0	40.5	91.2	129.2	175.0	109.8	94.2	82.8	109.8	103.4	109.8
17	36.1	32.0	40.5	91.2	129.2	175.0	109.8	94.2	82.8	129.2	103.4	80.0
18	36.1	32.0	36.1	91.2	103.4	175.0	109.8	94.2	82.8	129.2	103.4	80.0
19	36.1	32.0	36.1	91.2	109.8	175.0	109.8	94.2	82.8	129.2	103.4	80.0
20	34.0	32.0	54.8	103.4	109.8	178.9	109.8	94.2	82.8	129.2	103.4	80.0
21	36.1	32.0	116.2	103.4	109.8	187.0	109.8	100.3	82.8	129.2	103.4	80.0
22	34.0	32.0	45.1	103.4	109.8	165.6	109.8	97.2	82.8	129.2	103.4	80.0
23	33.0	32.0	40.5	103.4	109.8	203.5	109.8	97.2	82.8	129.2	103.4	72.2
24	32.0	32.0	45.1	116.2	109.8	203.5	109.8	97.2	82.8	103.4	103.4	72.2
25	32.0	32.0	45.1	116.2	103.4	203.5	109.8	97.2	82.8	103.4	103.4	72.2
26	32.0	32.0	54.8	122.7	91.2	203.5	94.2	94.2	82.8	103.4	103.4	72.2
27	32.0	32.0	69.6	129.2	91.2	203.5	94.2	.....	82.8	103.4	103.4	72.2
28	32.0	32.0	49.9	129.2	94.2	203.5	97.2	94.2	82.8	103.4	103.4	72.2
29	32.0	.....	36.1	129.2	97.2	203.5	97.2	94.2	82.8	103.4	103.4	72.2
30	32.0	.....	36.1	129.2	94.2	203.5	97.2	92.7	82.8	103.4	103.4	72.2
31	32.0	.....	40.5	.....	97.2	203.5	97.2	85.5	.....	103.4	.....	.....
Mean	36.0	32.0	43.1	88.4	119.7	175.3	128.2	95.4	83.4	98.9	103.4	82.4

Mean monthly run-off of Skaneateles outlet at Jordan, N. Y.

[Drainage area, 93 square miles.]

MEAN MONTHLY FLOW IN SECOND FEET.

	1890.	1891.	1892.
June	.....	127.8	.....
July	.....	115.3	.....
August	.....	153.1	128.5
September	156.6	146.6	116.5
October	153.9	148.7	121.2
November	155.2	.....	114.6
December	161.5	.....	.....

RUN-OFF IN SECOND-FEET PER SQUARE MILE.

June	.....	1.38	.....
July	.....	1.24	.....
August	.....	1.65	1.39
September	1.70	1.59	1.26
October	1.66	1.61	1.31
November	1.67	.....	1.24
December	1.75	.....	.....

RUN-OFF IN INCHES ON DRAINAGE AREA.

June	.....	1.55	.....
July	.....	1.43	.....
August	.....	1.89	1.59
September	1.90	1.78	1.41
October	1.91	1.85	1.51
November	1.87	.....	1.39
December	2.01	.....	.....

Actual run-off of Skaneateles outlet at Willowglen weir, in second-feet.

[Drainage area, 74 square miles.]

Month.	1895.	1896.	1897.	1898.	1899.	1900.	1901.
January	.....	80.0	64.5	68.6	75.5	16.0	36.0
February	.....	82.5	61.0	67.4	68.9	28.7	32.0
March	87.2	89.1	53.3	69.5	69.7	14.5	43.1
April	145.7	83.4	5.6	70.8	76.0	9.07	88.4
May	110.7	84.3	61.9	74.7	72.3	18.6	119.7
June	84.0	83.1	73.8	71.3	78.9	34.2	175.3
July	89.7	76.3	75.3	72.7	79.1	46.3	128.2
August	97.8	78.8	126.4	72.2	67.7	69.1	95.4
September	97.2	83.5	77.1	71.8	64.1	67.4	83.4
October	99.2	79.4	85.4	72.9	60.9	93.5	98.9
November	97.3	76.2	81.5	72.0	60.1	82.7	103.4
December	84.1	68.6	66.8	72.2	27.0	50.4	82.4

Total run-off of Skaneateles outlet at Willowglen weir, in second-feet.[a]

[Drainage area, 74 square miles.]

Month.	1895.	1896.	1897.	1898.	1899.	1900.	1901.
January	.....	93.0	76.8	81.6	90.8	30.7	53.8
February	.....	95.5	73.5	79.9	84.6	44.5	49.4
March	103.2	101.6	65.5	82.2	84.7	30.3	60.5
April	162.0	95.2	16.9	83.0	91.5	26.8	106.4
May	127.0	97.0	74.3	86.2	86.8	34.7	138.1
June	102.1	102.2	85.1	84.2	94.4	52.3	194.8
July	107.8	91.1	88.9	88.2	94.8	64.0	.....
August	114.5	92.2	138.4	86.6	84.6	88.2	.....
September	112.3	96.4	89.4	85.5	80.5	85.7	.....
October	113.9	91.2	97.4	87.1	76.4	111.2	.....
November	111.2	87.3	93.3	85.5	75.4	99.4	.....
December	96.7	82.8	79.1	85.5	42.5	66.8	.....

[a] Including diversion for water supply of Syracuse.

Mean monthly run-off of Skaneateles outlet at Willowglen weir, in second-feet per square mile.[a]

[Drainage area, 74 square miles.]

Month.	1895.	1896.	1897.	1898.	1899.	1900.	1901.
January	.....	1.25	1.04	1.10	1.23	.41	.73
February	.....	1.29	.99	1.08	1.14	.60	.67
March	1.39	1.38	.88	1.11	1.14	.41	.82
April	2.18	1.28	.23	1.12	1.24	.36	1.43
May	1.71	1.31	1.00	1.16	1.17	.47	1.86
June	1.37	1.38	1.15	1.14	1.27	.71	2.63
July	1.46	1.23	1.20	1.19	1.28	.87	.....
August	1.55	1.24	1.86	1.17	1.14	1.19	.....
September	1.51	1.30	1.21	1.15	1.09	1.16	.....
October	1.54	1.23	1.31	1.18	1.03	1.49	.....
November	1.49	1.18	1.24	1.15	1.02	1.34	.....
December	1.31	1.12	1.07	1.15	0.57	.91	.....

[a] Includes diversion for water supply of Syracuse.

Mean monthly run-off of Skaneateles outlet at Willowglen weir, in inches on drainage area.[a]

[Drainage area, 74 square miles.]

Month.	1895.	1896.	1897.	1898.	1899.	1900.	1901.
January	.....	1.44	1.19	1.27	1.41	.47	.84
February	.....	1.39	1.03	1.12	1.19	.62	.69
March	1.59	1.59	1.01	1.28	1.31	.47	.94
April	2.44	1.43	.26	1.25	1.39	.40	1.60
May	1.97	1.51	1.15	1.33	1.35	.54	2.14
June	1.55	1.55	1.29	1.28	1.42	.79	2.95
July	1.68	1.41	1.38	1.36	1.47	1.00	.....
August	1.78	1.43	2.14	1.35	1.31	1.37	.....
September	1.69	1.46	1.35	1.29	1.22	1.30	.....
October	1.77	1.41	1.51	1.36	1.18	1.71	.....
November	1.67	1.32	1.39	1.29	1.14	1.50	.....
December	1.51	1.29	1.23	1.32	.66	1.05	.....
Total	17.63	17.23	14.93	15.50	15.05	11.22	9.16

[a] Includes diversion for water supply of Syracuse.

Mean monthly run-off of Skaneateles Lake at State dam, Skaneateles, N. Y.

[Drainage area, 73 square miles.]

Month.	Mean monthly flow, in second-feet.		Run-off, in second-feet, per square mile.		Run-off, in inches, on drainage area.	
	1890.	1891.	1890.	1891.	1890.	1891.
January	.....	102.9	.....	1.43	.....	1.64
February	.....	115.2	.....	1.58	.....	1.64
March	.....	182.7	.....	2.51	.....	2.89
April	.....	186.6	.....	2.56	.....	2.87
May	.....	116.4	.....	1.59	.....	1.83
June	.....	96.4	.....	1.32	.....	1.48
July	.....	94.9	.....	1.30	.....	1.49
August	.....	.....	.....	.....	.....	.....
September	117.8	.....	1.62	.....	1.81	.....
October	100.88	.....	1.38	.....	1.59	.....
November	107.5	.....	1.48	.....	1.66	.....
December	113.4	.....	1.55	.....	1.78	.....

SENECA RIVER AT BALDWINSVILLE, ONONDAGA COUNTY, N. Y.

This gaging station has been described in Water-Supply and Irrigation Paper No. 36, page 183. Seneca River drains the central lake region of New York. The outlets of Otisco, Skaneateles, and Owasco lakes are crossed by the Erie Canal, and a portion of their flow is intercepted for water-supply purposes. Water from Lake Erie feeds the main canal as far as Port Bryon. Some of this water is discharged into Seneca River and thence returned to Lake Ontario.

The upper reaches of the stream are canalized, forming the Cayuga and Seneca canals, while dams on the lower portion admit of slack-water navigation, forming a part of Oswego Canal. During the summer but little water flows over the dam at Baldwinsville. In times of low water the mills are only allowed to run a certain number of hours

during the day, or until the supply accumulated in the pond above the dam is drawn down to a certain level.

The water is diverted through three power canals and conducted to the water wheels by means of short lateral channels. Power is used at 10 mills having a total of over 40 water wheels.

Current-meter measurements at Baldwinsville have been made as follows:

Current-meter measurements at Baldwinsville, N. Y.

Date.	Discharge.
June 11, 1900:	*Sec. feet.*
Oswego Canal	504.5
Main stream at railroad bridge[a]	1,183
Total flow	1,688
Flow in Amos race on same date	194
September 11, 1900 (no water flowing over dam):	
South Side Canal	475
Oswego Canal	317
Amos race	127
Total flow	919

[a] Including South Side canal and Amos race.

Owing to leakage of water wheels and penstocks, great difficulty is experienced in securing accurate results during low water at Baldwinsville. The stream has been examined at various other points with reference to the possible establishment of a current-meter station, and the following current-meter measurements have been made:

Current-meter measurements of Seneca River at Belgium (New Bridge), N. Y., in 1901.

	Discharge in sec.-feet.
May 23	5,279
June 6	5,014

Current-meter measurements of Seneca River at Jacks Reef bridge, September 11, 1901.

	Second-feet.
Discharge at Jacks Reef bridge	1,651
Discharge in "cut-off"	83
Total flow	1,734

Owing to slack water in the channels, backwater from dams below, and other causes, it has been found that the above stations could not be utilized at all stages of the stream. During 1901 repairs to the penstocks, water wheels, etc., at a number of the Baldwinsville mills have been made, greatly reducing the leakage, and the record at that station has been continued.

Mean daily flow, in second-feet, of Seneca River at Baldwinsville, N. Y., for 1900.

[Drainage area, 3,103 square miles.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	13.18	22.02	35.76	72.96	30.41	24.91	2.37	7.58	5.84	7.24	14.35	42.65
2	14.54	21.86	38.90	80.80	47.99	24.78	11.89	8.73	1.99	7.12	13.76	32.96
3	15.52	17.91	39.48	83.34	45.04	20.89	12.08	8.05	5.85	6.47	12.69	45.91
4	16.55	21.28	37.29	86.30	44.64	24.33	5.57	7.79	5.55	6.83	11.77	44.34
5	16.45	20.59	38.56	85.33	44.18	36.40	10.90	2.57	5.36	7.64	16.58	48.07
6	16.58	22.17	36.92	85.95	36.69	22.02	10.73	8.28	5.27	8.59	13.14	48.07
7	4.04	18.71	36.23	84.77	38.74	21.75	9.27	8.08	5.31	3.45	12.74	49.61
8	15.79	16.01	36.66	80.86	40.33	21.11	1.99	8.03	5.14	8.71	10.97	49.43
9	15.89	27.88	36.58	82.75	39.51	24.33	8.67	7.83	1.99	7.95	20.16	41.16
10	15.97	28.60	38.61	79.69	39.23	9.74	8.24	4.44	4.56	8.87	10.53	49.21
11	15.80	28.93	35.42	76.90	36.39	15.34	7.84	7.68	4.37	8.81	4.41	49.54
12	16.93	32.71	38.35	75.29	36.61	15.28	7.29	2.57	4.54	7.81	13.53	43.48
13	17.20	43.76	37.90	73.96	39.23	15.70	7.25	7.16	5.52	8.77	12.67	46.54
14	15.47	47.04	38.27	69.88	36.58	15.30	7.39	7.14	5.19	3.20	12.88	42.86
15	17.59	47.43	37.92	67.46	35.83	15.50	1.99	4.03	5.19	10.34	12.94	41.70
16	15.97	48.79	37.12	67.25	35.13	14.31	7.63	7.17	1.99	9.91	12.62	33.26
17	16.40	41.17	35.30	65.98	34.09	7.04	10.23	7.38	5.67	10.10	12.02	40.04
18	17.59	34.73	33.25	65.03	32.20	10.63	9.91	7.17	5.53	9.66	2.34	40.34
19	19.06	34.25	36.23	63.39	30.56	11.22	9.92	2.08	5.55	10.68	12.95	41.33
20	24.70	33.32	37.06	58.95	22.13	11.30	8.29	5.59	5.06	10.54	13.33	40.43
21	33.52	35.84	40.99	55.13	29.70	9.78	5.63	2.36	5.37	3.20	12.89	41.98
22	37.95	33.07	42.22	60.05	28.68	9.63	1.99	6.24	4.88	12.31	13.41	40.64
23	38.70	35.21	39.47	58.34	26.66	9.44	7.38	4.29	1.90	11.79	14.22	29.76
24	38.35	37.09	47.86	54.54	26.77	2.64	7.03	4.56	4.72	11.92	11.90	40.14
25	38.03	36.07	49.45	55.09	27.17	9.12	6.67	4.93	5.10	11.86	6.92	34.34
26	34.70	15.73	54.37	55.09	27.67	9.48	6.75	2.37	5.54	10.62	17.77	41.11
27	15.00	35.68	56.74	52.48	19.93	9.60	5.62	5.29	5.25	12.40	25.54	40.10
28	25.96	38.26	57.63	49.41	26.88	11.15	6.79	5.70	5.44	5.17	31.09	39.08
29	29.97	.....	62.38	48.14	25.53	10.50	1.99	5.67	5.33	15.47	31.36	37.63
30	27.01	.....	108.68	57.05	24.06	11.11	6.82	6.05	2.45	16.03	37.84	29.52
31	26.18	.....	75.01	.....	30.45	.....	7.14	6.05	.....	16.87	.....	33.90
Mean	21.50	31.29	44.41	68.45	31.20	15.08	7.20	5.51	4.71	10.63	14.98	41.26

Mean daily flow, in second-feet, of Seneca River at Baldwinsville, N. Y., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	21.41	22.81	20.72	84.12	87.90	39.65	35.32	17.35	3.21	19.81	21.19	19.90
2	33.61	21.59	19.37	81.92	86.70	31.01	34.04	16.40	18.68	19.55	19.66	22.89
3	24.98	17.05	16.94	81.66	85.32	45.11	32.08	14.91	19.10	18.65	11.27	25.87
4	22.53	23.11	21.89	83.57	80.04	45.35	31.23	9.17	21.71	21.22	20.24	23.78
5	21.68	20.09	21.76	85.07	67.28	44.82	30.20	15.53	21.32	20.75	20.14	21.39
6	11.90	19.39	20.70	84.42	75.47	44.52	30.95	15.55	23.02	11.80	19.39	21.95
7	22.40	15.88	21.51	78.88	74.18	45.94	23.02	17.34	19.29	21.96	20.24	21.70
8	23.51	16.88	21.21	89.36	70.53	47.87	27.57	18.17	12.91	20.16	20.35	16.83
9	23.91	18.75	18.73	90.97	67.53	43.26	29.01	16.67	20.74	19.79	19.38	22.76
10	25.26	12.75	16.63	92.02	64.50	51.20	26.87	16.97	18.04	19.22	11.27	21.37
11	19.77	19.92	24.90	96.75	60.25	49.96	25.01	8.88	20.60	20.17	20.63	26.67
12	32.66	20.06	26.38	96.78	51.78	50.48	25.33	18.71	22.01	19.84	20.77	28.67
13	28.30	18.36	28.13	96.43	58.75	48.37	24.26	17.24	18.74	10.08	21.79	29.57
14	36.62	18.29	28.55	89.43	53.07	45.93	15.18	16.94	20.19	22.90	21.38	29.04
15	36.06	19.35	32.58	93.90	54.80	48.06	23.47	16.99	13.03	19.38	22.48	42.76
16	38.43	20.02	34.04	93.07	53.39	39.70	22.31	17.10	22.73	19.22	22.20	47.08
17	37.80	14.95	32.86	88.11	49.01	43.54	18.58	17.20	22.09	18.96	13.84	48.08
18	35.45	21.24	38.55	86.85	46.99	40.86	18.30	6.82	19.69	20.95	21.72	46.81
19	23.43	18.69	40.37	86.42	39.75	39.34	18.13	16.30	17.12	19.83	23.63	45.51
20	21.06	18.27	43.76	79.32	43.85	39.75	17.69	15.18	18.12	13.59	21.43	43.76
21	26.97	18.18	50.89	89.95	43.35	37.63	9.48	16.84	19.47	21.01	22.10	40.69
22	28.55	18.50	55.89	88.68	43.61	40.96	12.95	17.15	9.60	19.94	23.39	38.71
23	27.80	19.27	59.83	90.80	44.09	38.03	11.29	16.84	20.30	20.10	20.68	40.63
24	27.69	18.86	56.29	95.99	44.35	45.74	11.70	15.67	19.89	18.86	13.97	38.59
25	28.22	21.17	64.81	95.14	40.28	43.68	10.61	11.46	18.83	18.97	25.76	42.37
26	27.15	22.67	66.80	96.54	30.90	43.55	10.88	18.22	17.63	18.92	24.16	40.98
27	21.43	19.21	75.90	88.99	40.00	41.17	10.44	18.39	17.52	12.61	26.77	38.97
28	27.38	21.98	77.91	94.78	38.54	39.05	6.35	18.48	17.78	20.26	21.96	40.74
29	24.02	.....	76.72	92.72	41.27	37.87	12.40	18.39	10.27	20.21	25.18	37.06
30	22.66	.....	76.61	92.72	39.26	29.31	12.52	18.87	19.21	18.87	23.78	40.96
31	12.74	.....	72.96	.....	43.23	.....	10.29	18.01	.....	18.81	.....	43.87
Mean	26.30	19.30	40.49	89.51	55.45	42.72	20.24	20.99	17.76	18.92	20.71	33.87

Mean monthly run-off of Seneca River at Baldwinsville, N. Y.

[Drainage area, 3,103 square miles.]

MEAN MONTHLY FLOW IN SECOND-FEET.

Month.	1898.	1899.	1900.	1901.
January		2,851	2,150	2,630
February		1,769	3,129	1,930
March		3,875	4,441	4,049
April		4,543	6,845	8,951
May		2,568	3,120	5,545
June		1,573	1,508	4,272
July		776	720	2,024
August		455	551	2,099
September		481	471	1,776
October		637	1,063	1,892
November	3,142	1,612	1,498	2,071
December	2,689	1,722	4,126	3,387
Year		1,905	2,469	3,386

RUN-OFF IN SECOND-FEET PER SQUARE MILE.

January		0.92	0.69	0.85
February		.57	1.01	.62
March		1.25	1.43	1.30
April		1.46	2.20	2.81
May		.83	1.00	1.79
June		.51	.49	1.38
July		.22	.23	.65
August		.15	.18	.68
September		.15	.15	.57
October		.20	.34	.61
November	1.01	.52	.48	.67
December	.87	.55	1.33	1.09
Mean		.61	.79	1.09

RUN-OFF IN INCHES ON DRAINAGE AREA.

January		1.06	0.79	0.98
February		.59	1.05	.64
March		1.44	1.65	1.50
April		1.63	2.45	3.14
May		.95	1.15	2.06
June		.57	.55	1.54
July		.29	.26	.75
August		.17	.21	.78
September		.17	.17	.63
October		.24	.39	.70
November	1.15	.58	.54	.74
December	1.00	.63	1.53	1.26
Year		8.28	10.74	14.72

ONEIDA RIVER AT BREWERTON, ONONDAGA COUNTY, N. Y.

Oneida River is a stream 16 miles in length connecting Oneida Lake, of which it forms the outlet, with Seneca River at Three River Point, where the two unite to form the Oswego River. A record of the water level at the foot of the lake at Brewerton was kept in con-

nection with the Topographic Surveys of the United States Deep Waterways from June 1 to September 9, 1899. The record has been furnished by Albert J. Himes, by whom it was established.

The gage erected by the United States Deep Waterways at Brewerton was an 8-foot board divided to feet and tenths attached horizontally to the downstream face of pier of footbridge across the channel leading to Zetts Island, at foot of lake. A lead weight and a wire running over a pulley were used to take readings. Some uncertainty exists as to the accuracy of the later portion of the record, owing to changing of the weight and wire. Gage readings were taken twice each day by George H. Meeker. The channel where the gage was placed is situated at the foot of the lake just above the highway bridge across Oneida River. Its water surface is subject to the same fluctuations of level as the lake surface, except during extreme low water, when, owing to its rapid fall, the elevation of the water in the channel is affected by surface slope. No current-meter discharge measurements have been made at Brewerton.

At Caughdenoy, about 3 miles downstream from Brewerton, occurs a natural rift, where a series of five eel weirs have been constructed, consisting of W-shaped barriers across the stream, with openings in the form of latticework through which the water passes, the crests of the eel weirs being near the water surface. The combined fall produced by these weirs at Caughdenoy is 4 feet. A lock on the right-hand side affords means for navigation past the weirs. A water-power privilege also exists in connection with the canal and lock at Caughdenoy, where a fall of 4 feet has been obtained.

Daily gage height, in feet, of Oneida River at Brewerton, N. Y., for 1899.

Day.	June.	July.	Aug.	Sept.	Day.	June.	July.	Aug.	Sept.	Day.	June.	July.	Aug.	Sept.
1	3.18	2.02	1.67	1.19	12	2.70	1.85	1.67	.....	23	2.35	1.76	1.27	.....
2	3.10	2.00	1.75	1.16	13	2.62	1.85	1.51	.....	24	2.26	1.84	1.25	.....
3	3.10	1.94	1.65	1.19	14	2.60	1.78	1.51	.....	25	2.26	1.93	.....	.....
4	3.10	1.94	1.66	1.13	15	2.58	1.80	1.57	.....	26	2.30	1.80	1.22	.....
5	3.02½	1.95	1.64	1.10	16	2.60	1.78	1.48	.....	27	2.28	1.79	1.30	.....
6	3.02	1.86	1.64	1.05	17	2.60	1.78	1.43	.....	28	2.24	1.80	1.22	.....
7	2.95	1.88	1.62	1.02	18	2.50	1.68	1.42	.....	29	2.13	1.76	1.23½	.....
8	2.75	1.80	1.62	1.02	19	2.50	1.73	1.39	.....	30	2.08	1.65	1.21	.....
9	2.82	1.79	1.62	.98	20	2.44	1.79	1.40	.....	31	.....	1.60	1.22	.....
10	2.78	1.79	1.70	.....	21	2.30	1.74½	1.42	.....					
11	2.74	1.88	1.75	.....	22	3.39	1.71	1.25	.....					

At Oak Orchard is a State dam and lock, the latter having a lift of 3.5 feet. On the left bank of the stream is an abandoned water-power privilege. The dam is of timber, with gravel backing, curved in plan. A short distance downstream is situated a highway bridge of six spans, where the conditions are favorable for measuring the stream with a current meter. During extreme high water the dams at Oak Orchard and Caughdenoy become entirely submerged. At such times backwater from the Phoenix dam on Oswego River extends

to Oneida Lake, producing a smooth surface curve the entire length of Oneida River.

LOW-WATER GAGINGS OF OSWEGO RIVER AT FULTON, OSWEGO COUNTY, N. Y.

The following table shows a summary of measurements to determine the flow of Oswego River for water-power purposes at the lower dam in Fulton. The measurements were made and the results furnished by O. C. Breed, C. E.

The water power at the dam is used jointly by five mills, each being entitled to a flow through an orifice of a certain area under the available head. In order to ascertain the amount of water used by each, the water was allowed to flow through openings formed in thin partitions in the sides of the bulkheads. The discharge through these openings was calculated by the formula for orifices, using as a coefficient 0.62.

Observations of the head on the orifices were taken at thirty-minute intervals throughout twenty-four hours each day. A record was also kept of the elevation of water surface above the crest of the dam. The elevation of the masonry crest of the dam is 102 feet. The dam is surmounted by flashboards having a top elevation of 103.20 feet. The water did not often flow over the flashboards. Such overflow, when it took place, has been calculated by means of the Francis formula, the length of the clear crest being 521 feet. The mean flow rate for each half-hour period has been obtained by summation of the discharge through the several orifices, and the flow over flashboards, if any. The mean daily flow in the table is the average of 48 such separate measurements.

Estimated minimum flow of Oswego River at Fulton, N. Y., in 1900.

Date.	Mean daily flow.		Maximum daily flow.	Minimum daily flow.
	Second-feet.	Second-feet per square mile.		
1900.			*Second-feet.*	*Second-feet.*
October 29	1,980	0.40	2,683	1,225
October 30	1,621	.33	2,069	1,111
October 31	1,776	.36	2,293	1,201
November 1	1,849	.38	2,420	1,132
November 2	1,752	.36	2,201	1,760
November 3	1,810	.37	2,259	1,540
November 4[a]				
November 5	1,665	.34	2,292	1,201
November 6	1,930	.39	2,351	1,309
November 7	1,842	.37	2,471	1,357
November 8	1,890	.38	2,415	1,539
November 9	1,611	.33	2,470	1,193
November 10	1,822	.37	2,245	1,293

[a] Sunday.

When the water stood at an elevation exceeding 102 feet a small amount of leakage took place through joints and cracks in flashboards. This occurred for only a few hours each day. The exact amount of such leakage is indeterminate, but the average rate, when distributed through the entire day, is so small that no serious error is introduced in the table by neglecting it.

The drainage area above the dam is 4,916 square miles, and the table shows a minimum run-off of one-third second-foot per square mile in 1900. The measurements given above were checked by rod floats through a 600-foot section of the river channel with rock bottom.

OSWEGO RIVER ABOVE MINETTO, OSWEGO COUNTY, N. Y.

Oswego River is formed by the junction of Oneida and Seneca rivers at Three Rivers Point. It has extensive natural storage in Oneida Lake, which covers an area of 80 square miles, and in the Finger Lakes of central New York, which it drains. Certain of the tributary lakes serve as reservoirs for the water supply of the middle division of Erie Canal, and a portion of their outflow is diverted for this purpose.

Mean daily elevation of water surface of Oswego River above Minetto for 1900.

[Drainage area, 4,990 square miles.]

Day.	Sept.	Oct.	Nov.	Dec.	Day.	Sept.	Oct.	Nov.	Nov.
1		83.52	84.27	86.99	17	83.97	84.09	84.62	89.00
2		83.52	84.27	86.84	18	83.52	84.02	84.47	89.35
3		83.49	83.42	87.19	19	83.35	83.99	84.42	89.15
4		83.62	83.42	87.19	20	83.57	84.47	84.92	89.10
5		83.62	84.17	89.30	21	83.65	83.02	84.92	89.05
6		83.62	84.42	90.15	22	89.62	83.77		89.10
7		83.02	84.51	90.15	23	83.89	84.32		89.00
8		84.12	84.47	90.15	24	83.57	83.62		89.05
9		83.87	84.37	90.00	25	83.07	83.62		88.80
10		83.62	84.27	89.80	26	83.37	83.67	84.64	88.90
11		83.82	83.67	89.70	27	83.52	83.67	85.44	87.59
12		83.97	84.67	89.50	28	83.45	82.72	86.09	87.29
13		84.02	84.57	89.50	29	83.47	84.12	86.54	87.14
14	83.45	83.57	84.62	89.35	30	83.42	84.22	87.09	87.04
15	83.47	83.65	84.62	88.95	31		84.37		86.29
16	83.67	83.87	84.57	88.95					

Mean daily elevation of water surface of Oswego River above Minetto for 1901.

[Drainage area, 4,990 square miles.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	86.54	87.24	84.79	92.65	92.35	87.89	87.37	84.79	84.69	84.88	84.98	86.06
2	86.24	86.89	85.19	92.60	92.15	87.89	87.24	84.67	84.89	84.87	85.13	85.93
3	86.09	86.49	85.59	92.80	91.80	87.90	87.12	84.67	84.79	84.83	84.93	85.91
4	85.99	86.34	85.74	92.65	91.65	87.64	87.02	84.47	84.94	85.03	84.88	85.88
5	86.44	86.24	85.59	92.65	91.45	87.42	86.92	84.59	85.04	85.03	84.81	85.93
6	85.84	86.19	85.44	92.70	91.25	87.24	86.82	84.69	85.04	84.68	84.93	85.88
7	85.94	86.04	85.39	92.60	91.20	87.97	86.77	85.17	84.99	84.78	84.98	85.86
8	86.04	86.04	85.69	92.75	91.00	87.00	86.66	84.84	85.09	84.83	84.93	86.08
9	86.89	85.74	85.89	92.65	90.80	87.00	86.64	84.72	85.24	84.83	84.88	86.48
10	86.59	84.44	86.04	92.60	90.60	87.09	86.64	84.64	85.22	84.93	85.13	86.53
11	86.94	85.19	86.04	92.80	90.30	87.09	86.34	84.67	85.14	85.08	85.23	86.73
12	87.04	85.29	86.24	92.80	90.10	87.15	86.42	84.99	85.22	84.83	85.18	87.08
13	87.19	85.19	86.29	92.70	89.95	87.31	86.42	84.64	85.04	84.53	85.28	87.45
14	87.24	84.99	86.84	92.50	89.80	87.54	85.79	84.64	84.94	84.88	85.28	86.38
15	87.34	85.09	86.94	92.45	89.65	87.67	85.84	84.79	84.58	85.03	85.23	86.33
16	87.54	85.09	87.04	92.50	89.55	87.69	85.74	84.74	85.23	85.03	85.53	85.53
17	86.94	84.99	87.24	92.55	89.25	87.79	85.64	84.74	85.13	85.08	85.13	85.43
18	86.64	84.84	87.39	92.60	88.80	87.51	85.47	84.74	84.98	85.03	85.18	85.48
19	86.54	84.74	88.75	92.85	87.64	87.39	85.34	84.64	85.13	85.13	85.13	85.53
20	86.39	84.74	89.35	93.15	88.60	87.39	85.27	84.49	85.18	84.83	85.18	85.93
21	86.04	84.84	90.70	93.45	88.40	87.37	85.04	84.52	85.33	85.13	85.28	86.23
22	86.74	84.79	90.10	93.45	87.54	87.39	85.27	84.49	84.88	85.13	85.28	86.18
23	86.89	84.89	90.70	93.35	87.47	87.39	85.19	84.64	85.18	85.88	85.38	86.08
24	86.74	84.99	90.70	93.40	87.44	87.49	85.24	84.69	84.88	84.83	85.78	85.88
25	86.54	85.09	92.55	93.45	87.39	87.57	85.09	84.59	84.98	85.88	85.96	85.83
26	86.44	84.74	93.05	93.35	87.39	87.39	85.14	85.04	84.68	85.08	86.06	85.73
27	86.24	85.04	92.90	93.35	87.49	87.94	85.14	84.94	84.88	84.93	86.43	85.78
28	86.69	84.69	93.65	93.35	87.49	90.65	85.24	85.14	85.28	84.98	86.53	86.03
29	86.84	.....	93.75	93.00	87.58	87.62	85.24	85.04	84.58	84.98	86.73	85.68
30	86.89	.....	93.55	92.60	87.62	87.42	85.04	84.94	84.78	85.08	86.83	86.08
31	86.99	.....	93.30	.....	87.40	.....	84.89	85.09	.....	84.98	.....	86.38

Estimated pondage areas in Oswego River drainage basin.[a]

Stream basin.	Drainage area.	Area of water surface.	Flats and marsh.	Total pondage area.	Percentage of entire drainage area.
	Sq. miles.	*Sq. miles.*	*Sq. miles.*	*Sq. miles.*	
Seneca	3,433	215	89	304	.....
Oneida	1,402	90	129	218	.....
Oswego	167	4	3	8	.....
Total	5,002	309	221	530	10.6

Oswego River has been canalized by the construction of dams affording slack-water navigation on a part of the stream. Surplus water at the State dam supplies power to the numerous mills situated along the adjacent banks. Lateral canals and locks carry boats around the dams and connect with backwater from the next succeeding dam in each instance.

In establishing a gaging station it was impossible to measure the entire stream in a single channel, since in order to avoid slack water from dams it was necessary to select a site where the river is paralleled by the canal. A cable station was established September 14, 1900, 3 miles above Minetto and three-fifths mile below the State dam at Battle Island. The cable has a clear span of 376 feet beween supports on the banks.

The stream channel underneath has a smooth sandstone bed. The gage board was placed on the left bank 2,930 feet upstream from the

[a] Report U. S. Board of Engineers on Deep Waterways, pt. II, p. 795.

cable. A weight gage is used, being suspended from a framework projecting over the water beyond the low-water margin. The position of the weight when the gage reads zero has been determined with reference to a fixed bench mark, and the gage readings are reduced to equivalent elevations of water surface referred to this bench mark. Morning and evening readings are taken, usually twelve hours apart, by H. L. Woodcock, and the average of the two readings is given in the tables.

The current-meter measurements given below do not include diversion through Oswego Canal.

Current-meter discharge measurements of Oswego River at cable station.

Date.	Elevation of water surface.	Discharge.	Hydrographer.
1900.	*Feet.*	*Second-feet.*	
September 15	83.57	1,677	R. E. Horton.
1901.			
August 27	84.98	2,938	E. C. Murphy.
Do	85.07	3,203	Do.
August 28	85.09	3,169	Do.
Do	85.09	3,066	Do.
August 7	85.12	3,270	Do.
Do	85.14	3,224	Do.
July 12	86.24	5,264	Do.
May 23	88.35	6,982	R. E. Horton.
April 13	92.77	18,452	Do.

On April 13, 1901, the depth of water flowing over the Battle Island dam, one-eighth mile above the gage, was observed for comparison with the current-meter measurement. The calculated discharge over the dam was 17,520 second-feet, not including leakage. The lowest water on the stream usually occurs Sundays, due to the stopping of water wheels and the consequent filling of mill ponds at Fulton, 4 miles upstream.

In this connection reference may be made to the gaging record which was maintained by the United States Board of Engineers on deep waterways on Oswego River at the Oswego Falls dam, from November, 1898, to May, 1899, inclusive. Description of this station may be found in Water-Supply Paper of United States Geological Survey, No. 36, page 188. The drainage areas tributary to Oswego River at the different gaging stations are as follows:

Drainage areas of Oswego River.

Location.	Drainage area.
	Sq. miles.
Mouth	5,002
High dam	5,000
Cable station	4,990
Fulton	4,916

OSWEGO RIVER AT HIGH DAM, OSWEGO COUNTY, N. Y.

This is a State dam on Oswego River, 3 miles from Lake Ontario, having its crest 32 feet higher than mean lake level, and affording an effective head of about 13 feet. The record is kept by the Oswego Waterworks Company, and has been furnished by Thomas H. Bennett, superintendent. The distance down to the water surface in the pond above the dam is measured from the top of a bulkhead having a known elevation with reference to the crest of the dam. Gage readings are taken daily, with the exception of Sundays and holidays.

Owing to the use of the stream for navigation purposes, an effort is made to keep the water up to a certain level at all times. The dam is of masonry, with a crest 365.5 feet long. Flashboards are maintained on the dam during the greater part of the year. When flashboards are on, the flow over the dam has been computed by means of the Francis formula. In estimating the flow when flashboards are removed, a discharge curve has been prepared using coefficients in the weir formula derived from Cornell Experiment No. 3,[a] and taking into consideration the irregularities in the profile of the crest. Since the record was started the water has not been down low enough to afford an opportunity for making a new profile of the dam. One which was made in 1896 has been used in the calculations.

No opportunity has been offered for directly measuring the leakage of the dam. Owing to the leakage and possible settlement of the dam since the profile used was obtained, the records as calculated probably give considerably too small results for low water, and may be revised upon the acquisition of new data. A headrace at the left-hand end of the dam diverts water to supply an electric-light plant and waterworks pumping station. Eight water wheels are in use. A regular record of the run of the water wheels has not been kept, and the diversion for this purpose has been estimated from current-meter measurements made in the headrace.

Measured flow in headrace at high dam.

Date.	Working head on wheels.	Measured discharge.
1900.	*Feet.*	*Second-feet.*
June 12	13	323
September 15	14	352

Three pairs of wheels, which were running when each of the above measurements were made, are run twenty-four hours per day. Taking the average of the above measurements and allowing 105 second-feet for the additional pair of wheels, the diversion for water power has been taken at 450 second-feet, as a round figure. The flow over the auxil-

[a] See Trans. Am. Soc. Civil Eng., Vol. XLIV, p. 374.

iary spillway at the end of the headrace has been calculated by the weir formula, using coefficients derived by Bazin for a dam having a similar cross section. Some uncertainty attaches to the record at high dam during the spring months, owing to the carrying away of the flashboards by high water at dates not definitely ascertained. In the accompanying tables of monthly and daily mean flow no allowance has been made for diversion to the Oswego Canal.[1]

The daily flow for December, 1900, has been recomputed and is here republished:

Mean daily flow, in second-feet, of Oswego River at high dam, Oswego County, N. Y., for 1900.

[Drainage area, 5,000 square miles.]

Day.	Dec.	Day.	Dec.	Day.	Dec.	Day.	Dec.
2	[a]9,580	10	10,760	19	7,840	28	8,120
3	8,960	11	9,880	20	7,840	30	[a]7,840
4	10,760	12	9,880	21	7,840	31	7,840
5	10,760	13	9,280	23	[a]8,680		
6	11,120	14	8,060	24	8,120	Mean	9,022
7	11,460	16	[a]7,840	25	8,060		
8	11,460	17	6,760	26	8,060		
9	[a]10,500	18	8,120	27	8,060		

[a] Sunday.

Mean daily flow, in second-feet, of Oswego River at high dam, Oswego County, N. Y., for 1901.

[Drainage area, 5,000 square miles.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	7,560	2,600	2,100	16,000	15,550	7,450	6,350	2,150	[a]1,750	1,875	2,450	[a]3,250
2	6,100	2,260	2,100	15,750	15,750	[a]7,850	6,250	2,150	2,100	1,875	2,450	4,050
3	4,640	[a]2,340	[a]2,340	15,750	15,250	8,400	5,850	2,150	2,300	1,875	[a]2,100	5,050
4	4,840	2,420	3,340	18,700	14,150	8,250	5,000	[a]1,750	2,050	1,875	1,900	5,750
5	5,860	2,260	3,660	17,850	[a]14,000	8,150	5,250	2,150	2,300	1,800	2,400	4,700
6	[a]4,640	960	2,100	17,100	13,450	8,150	5,200	2,050	2,200	[a]1,875	2,250	4,225
7	6,250	2,180	2,860	[a]16,900	12,800	7,850	[a]4,850	2,150	2,300	1,950	2,450	3,750
8	6,740	2,260	3,240	17,100	12,800	9,450	5,200	2,050	[a]1,700	1,875	2,300	[a]3,800
9	6,250	2,340	2,340	17,300	11,650	[a]10,100	5,200	2,050	2,050	1,875	2,150	4,800
10	6,520	[a]2,340	[a]3,640	17,500	11,150	9,750	4,500	2,050	1,950	1,950	[a]2,050	5,150
11	7,160	2,180	4,180	17,500	11,000	9,600	4,850	[a]1,900	1,750	1,950	1,850	5,400
12	5,940	960	4,560	17,650	[a]10,400	9,450	4,400	2,300	1,700	1,875	1,850	5,400
13	[a]7,560	920	4,640	17,650	10,860	9,000	4,300	1,700	1,700	[a]900	2,400	5,400
14	7,560	960	4,760	[a]17,500	10,400	8,550	[a]3,500	2,500	1,750	2,450	2,400	6,000
15	7,560	920	4,760	17,100	5,950	8,400	3,850	3,500	[a]1,750	2,075	2,400	[a]9,250
16	7,560	960	4,760	16,900	9,600	[a]7,850	3,400	1,625	1,950	2,050	2,800	10,400
17	8,120	[a]2,260	[a]4,760	16,900	9,450	8,000	3,100	1,550	1,950	2,150	[a]1,900	10,300
18	7,560	1,680	6,640	16,500	8,700	7,550	3,000	[a]1,250	1,950	2,450	3,350	10,150
19	2,480	1,740	6,900	15,550	[a]8,700	7,450	3,000	1,650	2,050	2,750	3,600	9,950
20	[a]3,440	1,680	7,700	16,900	8,400	7,000	2,450	1,750	2,100	[a]2,500	3,800	9,400
21	3,960	2,260	8,540	[a]17,100	8,250	7,450	[a]2,300	1,750	2,100	2,550	3,950	8,300
22	3,760	2,340	11,460	17,100	8,700	7,556	2,700	1,550	[a]1,550	2,700	3,800	[a]7,67[illegible]
23	3,860	1,800	11,460	17,300	7,300	[a]7,700	2,600	1,750	1,950	2,550	3,500	8,10[illegible]
24	4,640	[a]2,340	[a]11,600	17,300	6,900	8,400	2,700	1,750	1,750	2,400	[a]3,450	7,90[illegible]
25	4,080	2,100	12,740	17,850	7,150	8,550	2,600	[a]1,950	1,750	2,400	4,475	.....
26	4,080	1,860	12,960	16,300	[a]6,600	8,250	2,350	1,950	1,700	2,200	3,800	7,65[illegible]
27	[a]3,240	1,800	(b)	[a]16,500	6,900	7,700	2,350	1,875	1,700	[a]2,150	3,800	7,67[illegible]
28	3,540	1,740	17,650	16,500	6,900	7,450	[a]2,050	1,750	1,250	2,500	3,800	7,32[illegible]
29	3,340	.....	16,500	16,300	6,900	7,000	2,300	1,750	[a]1,150	2,400	3,800	[a]7,35[illegible]
30	3,340	.....	16,500	16,700	7,300	[a]6,250	2,300	1,625	1,875	2,450	8,800	8,72[illegible]
31	3,240	.....	[a]16,300	.....	7,300	.....	2,200	1,625	.....	2,400	.....	8,32[illegible]
Mean	5,326	1,874	7,270	16,967	10,006	8,152	3,740	1,928	1,871	2,150	2,901	6,80[illegible]

[a] Sunday. [b] Exceeds limit of rating curve.

[1] Tables of daily gage heights, etc., at this station are given in Water-Supply Paper of U. S. Geol. Survey, No. 36, p. 189.

Mean monthly run-off of Oswego River at high dam, Oswego County, N. Y.

[Drainage area, 5,000 square miles.]

MEAN MONTHLY FLOW IN SECOND-FEET.

Month.	1897.	1898.	1899.	1900.	1901.
January	.....	4,896	4,252	3,077	5,326
February	.....	6,238	2,475	4,653	1,874
March	.....	9,898	4,874	4,991	7,270
April	10,048	7,578	7,684	14,025	16,957
May	6,166	8,161	6,754	7,645	10,006
June	3,801	4,331	2,002	3,132	8,152
July	2,174	1,834	748	966	3,740
August	2,370	925	612	669	1,928
September	1,244	1,377	615	670	1,871
October	1,076	2,018	585	853	2,150
November	1,821	4,452	1,095	2,418	2,901
December	4,168	3,899	1,612	9,022	6,806
Year	.....	4,634	2,776	4,343	5,748

RUN-OFF IN SECOND-FEET PER SQUARE MILE.

January	.....	0.98	0.85	0.61	1.07
February	.....	1.24	0.49	0.93	0.37
March	.....	1.99	0.97	0.99	1.45
April	2.00	1.51	1.53	2.80	3.39
May	1.23	1.63	1.35	1.53	2.00
June	0.76	1.66	0.40	0.62	1.63
July	0.43	0.36	0.15	0.19	0.75
August	0.47	0.18	0.12	0.13	0.39
September	0.25	0.27	0.12	0.13	0.37
October	0.21	0.40	0.11	0.17	0.43
November	0.36	0.89	0.22	0.48	0.58
December	0.83	0.78	0.32	1.80	1.36
Year	.....	0.99	0.55	1.42	1.15

RUN-OFF IN INCHES ON DRAINAGE AREA.

January	.....	1.13	0.98	0.70	1.23
February	.....	1.29	0.51	0.96	0.38
March	.....	2.29	1.12	1.14	1.67
April	2.23	1.68	1.70	3.12	3.80
May	1.78	1.78	1.55	1.76	2.30
June	0.85	1.85	0.44	0.69	1.83
July	0.49	0.41	0.17	0.22	0.86
August	0.54	0.20	0.14	0.15	0.45
September	0.28	0.30	0.13	0.14	0.41
October	0.24	0.46	0.12	0.19	0.49
November	0.40	0.99	0.24	0.53	0.65
December	0.95	0.90	0.36	2.08	1.57
Year	.....	13.28	7.46	11.68	15.64

GENESEE RIVER AT ROCHESTER, MONROE COUNTY, N. Y.

Genesee River rises in Potter County, Pa. It flows northerly, crossing the State of New York and entering Lake Ontario at Charlotte.

There is a total fall of 263 feet within the city of Rochester, chiefly divided between three cascades, with an aggregate abrupt pitch of 205 feet, the remaining fall being distributed between dams and rapids. There are extensive water-power developments at each fall.[a] In the vicinity of Portage the stream flows through a narrow gorge in Lockport (Niagara) limestone, where a total fall of 330 feet occurs. Of this, about 266 feet is in three abrupt pitches. There is a descent, including rapids, of 70, 110, and 150 feet, respectively, at the three principal falls.

Beginning in March, 1893, a record has been kept of the daily elevation of water surface in the pond above Johnson and Seymour dam in Rochester. This record has been furnished by Mr. E. A. Fisher, city engineer. The final results are not ready for publication. The following tables show a summary of the monthly variations in water level. The Johnson and Seymour dam affords power for 25 miles under a head of 19 feet. Water is drawn through two canals, one at each end of the dam. These canals take the entire flow of the stream during dry months. A State dam, a short distance upstream, diverts water for supply of Erie Canal. Previous gaging records for Genesee River have been published in Reports of the State Engineer and Surveyor of New York and of United States Geological Survey, as described below.

A gage board was placed above the timber dam of the Mount Morris Hydraulic Power Company by Aug. Kibbie, and a record kept there from June 17 to December 2, 1890. The flow over the dam, which had a somewhat irregular crest 337 feet in length, was computed by the weir formula, using a constant coefficient of 3.4. An allowance of 100 second-feet was made for leakage and diversion for power purposes. The results of Mr. Kibbie's gagings are to be found in Report of New York State Engineer and Surveyor, 1890, plate 11, Appendix F.

In May, 1893, a gage was reestablished at the Mount Morris Dam, by George W. Rafter. Diagrams showing the results of these gagings for the period from August, 1893, to January, 1895, inclusive; and February, 1895, to November, 1896, inclusive, are to be found in the Reports of the State Engineer and Surveyor, 1894, page 336, and 1896, page 644, respectively. During the summer of 1896 a sharp-edged weir was established in Genesee River, 2½ miles below the Mount Morris dam. Simultaneous observations taken at the weir and dam were used to accurately calibrate the latter for flows up to 5,000 second-feet. The Francis formula was used for calculating the flow over the weir. The corrected monthly mean flows, September, 1893, to November, 1896, inclusive, are given in the Twentieth Annual Report of United States Geological Survey, Part IV, pages 225–227. The sharp-edged weir at Mount Morris was injured by flood in October, 1896,

[a] Tenth U. S. Census, Vol. XVI, pp. 469–470; also, Report of New York State Engineer and Surveyor, 1896, pp. 714 and 715.

and has never been repaired. The old Mount Morris dam was carried away by high water March, 1897.

Drainage area of Genesee River.

Location.	Area.
	Sq. miles.
At Portage Falls	1,000
At Mount Morris	1,070
At Rochester	2,365
At Mouth	2,446

Unusual floods have occurred on Genesee River in 1815, 1835, 1857, 1865, 1889, 1894, and 1896.[1] The following are the calculated maximum rates of discharge:

Maximum discharge of Genesee River.

Location.	Date.	Discharge.	Discharge per square mile.
		Second-feet.	*Second-feet.*
Rochester	Mar. 19, 1865	40,000	17.0
Do	June 1, 1889	27,000	11.4
Mount Morris	May 2, 1894	42,000	39.2

The lesser intensity of floods at Rochester is attributed largely to surface storage due to flooding of extensive intervening flat lands bordering the river.

Monthly elevation, above sea level, of Genessee River at the Johnson and Seymour dam, Rochester, N. Y.

[NOTE.—The elevation of the crest of the Johnson and Seymour dam is 241.91 feet.]

Month.	Maximum elevation.						
	1893.	1894.	1895.	1896.	1897.	1898.	1899.
January		244.86	243.33	243.55	244.08	245.44	245.85
February		244.93	242.31	244.58	242.91	246.15	244.15
March	246.41	247.04	245.24	246.96	246.13	245.55	245.17
April	244.65	246.08	246.26	[b]249.47	244.20	245.25	244.92
May	245.78	248.34	242.43	242.49	243.86	243.85	243.09
June	[a]241.68	245.20	242.28	243.12	242.22	242.57	242.11
July	[a]240.88	242.17	241.99	242.18	242.71	242.27	[a]241.10
August	[a]244.40	242.13	[a]241.77	242.30	242.50	243.53	[a]239.40
September	243.68	245.18	[a]241.71	[a]240.73	[a]240.40	241.99	[a]240.27
October	243.43	243.52	[a]239.88	245.55	[a]240.27	243.61	[a]240.38
November	243.65	243.16	242.57	242.92	242.71	245.55	242.36
December	246.36	242.85	245.29	244.18	243.75	245.85	243.75
Year	246.41	248.34	246.26	249.47	246.13	246.15	242.71

[a] Elevation of water surface is below crest of dam.
[b] High water of April 1, 1896.

[1] Described in Report of New York State Engineer and Surveyor, 1896, pp. 639-644.

Monthly elevation, above sea level, of Genesee River, etc.—Cont'd.

Month.	Minimum elevation.						
	1893.	1894.	1895.	1896.	1897.	1898.	1899.
January	.....	242.23	[a]241.28	[a]241.70	[a]241.15	[a]240.45	242.15
February	.....	242.12	[a]240.81	242.23	[a]241.42	242.08	[a]241.85
March	241.93	242.54	243.09	242.44	242.29	242.72	242.84
April	241.95	242.66	242.34	242.49	242.67	242.28	242.55
May	[a]241.76	242.34	[a]241.88	[a]241.50	242.15	242.37	242.02
June	[a]239.96	242.06	[a]239.22	[a]241.66	[a]239.65	[a]241.82	[a]239.42
July	239.28	[a]240.24	[a]239.18	[a]239.61	[a]239.69	[a]239.30	[a]239.05
August	[a]239.18	[a]239.85	[a]239.18	[a]239.28	[a]239.13	[a]241.15	[a]238.86
September	[a]241.03	[a]239.26	[a]239.02	[a]239.08	[a]238.95	[a]240.12	[a]238.85
October	[a]240.50	[a]240.98	[a]239.01	[a]240.95	[a]238.85	[a]240.20	[a]239.00
November	[a]241.43	242.16	[a]239.25	[a]240.91	[a]238.83	242.06	[a]240.05
December	242.26	240.96	[a]239.11	[a]239.05	[a]241.39	241.45	[a]240.69
Year	[a]239.18	[a]239.26	[a]239.01	[a]239.05	[a]238.83	[a]239.30	[a]240.61

Month.	Mean elevation.						
	1893.	1894.	1895.	1896.	1897.	1898.	1899.
January	.....	243.15	242.35	242.30	242.34	242.92	243.38
February	.....	242.97	[a]241.42	243.12	242.50	243.37	242.45
March	243.51	244.22	243.66	243.70	244.09	243.81	243.41
April	243.27	244.12	243.59	244.59	243.12	243.09	243.24
May	243.15	245.50	242.23	242.09	242.63	242.82	242.34
June	[a]240.80	243.05	[a]241.78	242.14	[a]241.26	242.16	[a]240.92
July	[a]239.95	[a]241.33	[a]240.28	241.94	[a]241.50	[a]240.70	[a]240.03
August	[a]239.67	[a]241.39	[a]240.30	[a]240.69	[a]239.64	242.20	[a]239.10
September	242.12	[a]241.86	[a]239.43	[a]239.51	[a]239.32	[a]241.08	[a]239.25
October	[a]241.81	[a]241.85	[a]239.23	242.59	[a]239.22	[a]241.71	[a]239.51
November	242.09	242.61	[a]240.83	242.06	[a]240.69	242.87	[a]241.60
December	243.44	242.22	[a]241.53	242.16	242.19	242.63	242.36
Year	241.98	242.85	[a]241.38	242.24	[a]241.54	242.45	[a]241.47

[a] Elevation of water surface is below crest of dam.

MOHAWK RIVER DRAINAGE.

Despite its importance as a source of power and as an avenue of commerce, very little was known as to the water-yielding capacity of Mohawk River prior to the investigations of the United States Board of Engineers on Deep Waterways. The results of gagings of the discharge of the stream over dams at Ridge Mills, Little Falls, Rocky Rift, Rexford Flats, and Dunsbach Ferry are given below. Gaging records have also been maintained at a current-meter station near Schenectady and for the determination of the discharge by the slope formula at a number of points. At present there are available simultaneous records for the high-water period of 1901 on the lower Mohawk, obtained by three distinct methods—the Weir formula, the current meter, and the slope formula.

The regimen of the Mohawk River during the navigation season is undoubtedly modified to a large extent by the influence of the Erie Canal, by which the river is paralleled from Rome to Cohoes, a distance of 110 miles. The water supply of the Erie Canal east of the summit level at Rome is, with a single exception, derived from Mohawk River and its tributaries. At Rome water enters the watershed which has been brought from adjacent drainage areas, feeding the western end of the summit level. In addition, water from Black River watershed is brought in through Black River Canal.

New York State dams and canal feeders in Mokawk Valley.

Stream.	Location.
Mohawk River	Delta, 6 miles above Rome, Oneida County, N. Y.
Do	Rome, Oneida County, N. Y.
Oriskany Creek	Oriskany, Oneida County, N. Y.
Mohawk River	Little Falls, Herkimer County, N. Y.
Do	Five Mile or Rocky Rift dam, Herkimer County N. Y.
Schoharie Creek	Fort Hunter, Montgomery County, N. Y.
Mohawk River	Rexford Flats, Saratoga County, N. Y.

A large diversion from the watersheds of these feeders is in some measure counterbalanced by return water to the main stream channel from seepage through canal and feeder banks and flow over waste weirs.

The complex character of the run-off of the Upper Mohawk River is shown by the following current-meter measurements which were made on August 18, 1901, at a time when no canal boats were passing, so that the level of water in each case remained statical during the measurements:

	Sec.-ft.
Flow from Mohawk River into Delta feeder	48.8
Flow in Mokawk River at bridge, 1 mile below feeder	145.2
Total flow of Mohawk River at Delta	194.0
Flow in Black River Canal below Delta	110.1
Diversion from Mohawk as above	48.8
Diversion into Mohawk Valley through Black River Canal above Delta	61.3

This does not take into consideration diversion or return waters from Lansingkill which parallels Black River Canal above Delta.

August 31, 1900, the diversion to Erie Canal at Rome feeder was found by current-meter measurement to be 150 second-feet. The flow in the stream channel below the dam on the same date was 38 second-feet.

Measurements of the flow in Forestport feeder of Black River Canal were made in connection with the Barge Canal survey in 1900.[a]

The column in the following table showing flow in canal south of feeder represents the inflow from Black River watershed to Mohawk River watershed on the dates named:

Measurements of flow of Forestport feeder of Black River Canal.

Date.	Observed discharge of feeder.	Flow in canal south of feeder.	Observed flow over waste weir.	Observed flow in canal north of feeder.
1900.	*Second-feet.*	*Second-feet.*	*Second-feet.*	*Second-feet.*
August 31	254.35	197.37	0.00	61.72
September 24	310.57	242.18	2.10	70.15
November 7	323.06	254.23	0.00	68.83
December 1	353.23	181.20	3.00	69.03

[a] See report of engineer for water supply, p. 919.

The gaging records at Rexford Flats and at Little Falls indicate that the yield of the watershed in second-feet per square mile, and frequently also the actual flow in second-feet, is considerably less during the navigation season at the former than at the latter station. The drainage area above Rexford Flats is 3,385 square miles, or 2.6 times that at Little Falls, which is 1,306 square miles. The diminished water-yielding capacity of the lower Mohawk Basin may be attributed in part to the low water of Schoharie Creek. The drainage area of Schoharie Creek is 947 square miles. Weir measurements at Schoharie Falls show that the flow sometimes falls below 50 second-feet. During practically the entire summer no water flows over the crest of the State dam at Fort Hunter. The major portion of the flow is diverted to the Erie Canal feeder and the remainder leaks through the dam. During the present summer, from June to October, inclusive, the direct inflow to the Mohawk from this tributary did not, with the exception of a few days, exceed 45 second-feet or 0.05 second-foot per square mile.

MOHAWK RIVER AT RIDGE MILLS, ONEIDA COUNTY, N. Y.

Mohawk River rises in Lewis County and flows southerly from Oneida County to Rome, where it turns to the east and finally empties into the Hudson River at Cohoes. It is shown through the greater portion of its length on the Oneida, Oriskany, Utica, Little Falls, Canajoharie, Fonda, Amsterdam, Schnectady, and Cohoes topographic sheets of the United States Geological Survey.

The greatest fall occurs at the mouth of the stream at Cohoes, where there is a descent of 105 feet over Hudson River shale, extensive water-power development being carried out through the construction of a long headrace, from which the water is drawn off into lateral canals, utilizing the total fall in five different levels. From Cohoes to Little Falls the stream valley is broad, with moderate side slopes, and the course of the stream usually winding. A barrier of rock crosses the valley at Little Falls, where a gorge has been formed with sides 400 feet high, in passing through which the stream descends 42 feet. Above Little Falls, to a point near Rome, the stream is sluggish and tortuous, winding through a flat valley or flood plain, which is overflowed during high water.

The gaging station at Ridge Mills is located at the dam of the Rome city waterworks, 3 miles above Rome. The dam is of rough timber, with plank facing, having a slightly irregular crest 122.7 feet in length, which is divided into several sections, each assumed to be level to facilitate discharge computations. During the year 1900 the calculated discharge of the turbines has been made to depend on current-meter measurements instead of on the observed wheel-gate openings as formerly. The pump house, adjacent to the dam, contains two 60-inch Helmer turbines. The discharge through these is sensibly proportional to the rate at which the waterworks pumps, which they

drive, are run. A straight-line diagram has been prepared, using the following data, from which the flow through the turbines has been taken.

Flow in tailrace at Ridge Mills, N. Y.

Date.	Speed of pumps.	Measured flow in tailrace.
1900.	*Revolutions per minute.*	*Second-feet.*
May 29	15	122
August 23	12	95

A measurement of the leakage of the dam was made in the stream channel below, August 23, 1900, when no water was flowing over the crest. The leakage was found to be 20 second-feet, and an allowance for this amount has been made in estimating the daily flow. A rough current-meter measurement of the discharge at the bridge crossing the pond above the dam, April 22, 1900, showed the inflow to the pond to be 1,385 second-feet. August 31, 1900, the total flow of the stream at Riverside Park, 1 mile below the dam, was found to be 188 second-feet.

The gaging record at Ridge Mills does not include any allowance for diversion to Black River Canal at Delta feeder, 4 miles upstream, nor for return water from seepage and waste weirs. Water for the municipal supply of Rome is taken from Mohawk River at Ridge Mills, the amount of diversion averaging 2,500,000 gallons per day, equivalent to a continuous flow of 4 second-feet. The dam was injured by the flood of November 26, 1900, and the record discontinued. On November 26, 1900, the maximum calculated discharge of 4,940 second-feet occurred, corresponding to a flow of 32.3 second-feet per square mile of the tributary drainage area of 153 square miles. March 12, 1898, a discharge rate of 5,266 second-feet was obtained. This is equivalent to 34.5 second-feet per square mile. The highest previous freshet reported occurred in the spring of 1898, the calculated discharge being 7,080 second-feet, or 46.4 second-feet per square mile. During extreme high water some discharge takes place through overflow channels under the highway at the left of the dam. This has been included in the above estimates.

ORISKANY CREEK AT ORISKANY, ONEIDA COUNTY, N. Y.

This stream rises in Oneida County, N. Y., and flows in a northerly direction, emptying into the Mohawk River.

The location of this station, as well as that of a second station which was maintained for a time at Coleman on this stream, is shown on the Oriskany atlas sheet of the United States Geological Survey.[a]

[a] See Water-Supply and Irrigation Paper, U. S. Geol. Survey, No. 35, p. 47. The record kept at Coleman is described in Report U. S. Board of Engineers on Deep Waterways, Part II, pp. 594-595.

The Oriskany station is located at the New York State dam, which is of timber, having a crest 214 feet in length with a somewhat irregular profile, which, in order to facilitate computation, has been divided into three sections, each assumed to be level, its elevation being taken equal to the average elevation of this portion of the profile. The dam is low, the difference of elevation on the upstream and downstream sides ordinarily being about 4 feet. During extreme high water the dam becomes completely submerged. During the summer the entire flow, less leakage, is ordinarily diverted to the canal feeder. H. Waterbury & Co.'s dam, located just below the State dam, backs water above the toe of the latter, so that direct measurements of the leakage of the State dam can not readily be made.

During the winter and spring the flow of the stream is available for power from the lower dam, but during the season of navigation the inflow to the Mohawk from this tributary amounts to only a few second-feet. The computed flow at the gaging station represents the total outgo from the pond above the State dam and includes water diverted from Chenango River through the channel of Oriskany Creek to feed the Erie Canal.

A record is kept of the height of water in the pond above the dam and also in the feeder channel below the head gates. The observed difference or head on the feeder gates, together with the area of the gate openings, have been used in the formula for discharge through submerged orifices to determine the flow. A screen rack in the fore bay, just above the feeder gates, often becomes clogged with drift, causing a loss of head of several inches. In order that the correct head on the feeder gates might be obtained, a gage was placed in the fore bay, between the screen rack and feeder gates, at the beginning of the navigation season of 1900.

During the dry season the gateways leading to the feeder are wide open, and the water flows through unobstructed, as in an open channel, so that the formula for orifices can not be applied.

In this connection the difficulties encountered in gaging the flow in canal feeders are worth comment. Broadly speaking, the amount of water required for the supply of canals is proportional to lockage and evaporation jointly, with perhaps a constant factor added for seepage losses. As a matter of fact, however, the rate of flow in the feeder often fluctuates within wide limits several times a day. Gates are usually placed in both the inlet and outlet ends of the feeder channel. The stage or height of the water in the feeder is influenced by that of the water in the canal itself, as well as in the supply pond above, while the velocity of flow may be varied by changes in the gate openings at either end. Isolated discharge measurements are of value in a general way, but it may be said that nothing short of a continuous record both of the stage of the water in the feeder and of its velocity of flow will serve to determine the actual diversion from day to day.

Mean monthly run-off of Oriskany Creek at Oriskany, N. Y.

[Drainage area, 144 square miles.]

Month.	Mean monthly flow, in second-feet.			Run-off, in second-feet, per square mile.			Run-off, in inches, on drainage area.		
	1898.	1899.	1900.	1898.	1899.	1900.	1898.	1899.	1900.
January		295	199		2.04	1.38		2.35	1.59
February		291	378		2.02	2.62		2.10	2.72
March		342	386		2.37	2.67		2.73	3.07
April		466	488		3.23	3.38		3.60	3.77
May		119	136		0.83	0.94		0.95	1.08
June		99	95		0.69	0.66		0.77	0.73
July		180	100		1.25	0.69		1.44	0.79
August		186	103		1.29	0.71		1.48	0.81
September		126	73		0.87	0.51		0.97	0.57
October	325	91	85	2.25	0.63	0.59	2.59	0.72	0.68
November	327	360	255	2.27	2.49	1.78	2.53	2.77	1.99
December	327	89	272	2.27	0.62	1.90	2.61	0.71	2.19

Current-meter discharge measurements of Oriskany feeder.

Date.	Discharge.	Hydrographer.
1898.	*Second-feet.*	
October 13	77.94	W. D. Lockwood.
October 15	49.55	Do.
October 15 [a]	118.89	Do.
1900.		
April 28	167.95	R. E. Horton.
May 29	103.20	Do.
August 7	100.70	E. C. Murphy.
August 8	62.20	Do.
August 10	84.00	Do.
August 11	100.00	Do.
1901.		
May 1	87.80	R. E. Horton.
May 1 [a]	109.60	Do.
May 2	173.00	Do.

[a] Second measurement made after a change in feeder-gate openings.

April 30, 1900, the discharge from Oriskany Creek to Mohawk River was measured below H. Waterbury & Co.'s mill, Oriskany, and found to be 84 second-feet.

ORISKANY CREEK AT WOOD ROAD BRIDGE, ORISKANY, ONEIDA COUNTY, N. Y.

Owing to difficulty of determining summer flow with precision, the original gaging station at the State dam in Oriskany was abandoned January 31, 1901.[a] This station was replaced on June 26, 1901, by a current-meter gaging station at Wood road bridge, one-half mile farther upstream. The location of this station may be seen on the Oriskany sheet of the Topographic Atlas of the United States Geological Survey. An 8.5-foot standard cypress gage board, divided to feet and tenths and set in a vertical position, was attached to the upstream side of the right-hand abutment of the bridge, from which readings of the stage of the stream are taken twice daily by the gage reader,

[a] See description, p. 146.

Charles W. Smith. The bridge stands squarely across the channel and has vertical masonry abutments and a span of 80 feet. The bench mark is situated on the northwest corner of the upstream side of the bridge seat, on the right-hand abutment.

Elevation of bench mark	100.00
Elevation of gage zero	86.34

Owing to cross currents underneath the bridge at times of low water, the current-meter measurements are made by wading at a point 300 feet below the bridge. During 1901 the following discharge measurements were made:

Discharge measurements of Oriskany Creek during 1901.

Date.	Gage height.	Discharge.
	Feet.	*Second-feet.*
August 29	1.58	77.2
August 19	1.58	73.5
August 27	1.60	79.3
October 11	1.71	81.0
June 26	2.10	196.8

A rough measurement of the discharge at Wood road bridge May 1, 1900, showed a total flow of 289 second-feet.

The flow of Oriskany Creek at Wood road bridge represents the natural run-off of the tributary watershed of 144 square miles, modified by pond storage at numerous mills, with the additional flow during summer months due to diversion from storage reservoirs in Chenango River watershed through the summit level of the abandoned Chenango Canal into Oriskany Creek. The relation between the effective watershed during the canal season and during the winter months is shown below:

Drainage area of Oriskany Creek.

	Square miles.
Natural drainage area above gaging station	143
Chenango River area made tributary through Chenango Canal in summer	87
Total effective drainage during navigation season	230
Effective drainage area canals closed	143

Storage reservoirs on Chenango River.[a]

Name of reservoir.	Storage depth	Average surface area.	Impounding capacity.
	Feet.	*Acres.*	*Cubic feet.*
Eaton Brook	50	254	533,212,000
Hatch Lake	10	134	58,370,400
Bradley Brook	25	134	145,926,000
Kingsley Brook	20	113	98,445,900
Madison Brook	40	235	460,647,000
Leland Pond	8	173	59,287,000

[a] Report of the Engineer for Water Supply, N. Y. Barge Canal Survey, 1901, p. 673.

Owing to the maintenance of an equable summer flow through draft from these storage reservoirs, Oriskany Creek forms an excellent water-power stream.

Daily gage height, in feet, of Oriskany Creek at Wood road bridge, Oriskany, N. Y., for 1901.

Day.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	1.8	1.8	2.25	1.8	1.8	3.7
2	.....	1.8	1.8	2.2	1.85	1.7	3.65
3	.....	1.85	1.65	2.1	1.9	1.75	3.5
4	.....	1.75	1.6	1.7	1.8	1.7	3.4
5	.....	1.95	1.55	1.7	1.9	1.7	3.25
6	.....	2.9	1.6	1.65	1.8	1.7	2.7
7	.....	2.3	1.9	1.6	1.75	1.6	2.6
8	.....	2.1	1.9	1.55	1.7	1.75	3.5
9	.....	1.95	1.9	1.55	1.6	1.7	4.25
10	.....	1.85	1.75	1.5	1.7	1.7	5.55
11	.....	1.85	1.7	1.65	1.65	1.9	4.3
12	.....	1.75	1.8	1.8	1.6	2.4	2.45
13	.....	1.85	1.6	1.8	1.85	2.75	2.6
14	.....	1.75	1.5	1.8	1.8	2.4	3.9
15	.....	1.75	1.6	1.9	1.9	2.1	7.35
16	.....	1.7	1.85	1.75	1.9	1.95	4.25
17	.....	1.95	1.7	1.8	1.9	2.2	3.4
18	.....	1.95	1.7	1.7	2.0	2.4	3.0
19	.....	1.7	1.65	1.7	2.0	2.25	2.65
20	.....	1.45	1.6	1.7	2.0	2.05	2.65
21	.....	1.6	1.8	1.65	1.95	2.25	2.8
22	.....	1.65	1.8	1.7	1.85	2.3	2.9
23	.....	1.7	1.65	1.7	1.8	2.45	2.8
24	.....	1.7	1.6	1.65	1.9	2.45	3.05
25	2.2	1.6	1.6	1.6	1.7	2.7	3.7
26	2.15	1.7	1.65	1.6	1.75	2.7	3.5
27	2.0	.....	1.65	1.75	1.8	2.65	3.35
28	1.95	1.6	1.35	1.55	1.8	2.6	3.3
29	2.0	1.8	1.4	1.75	1.75	2.95	4.35
30	1.8	1.85	1.6	1.95	1.7	3.65	4.3
31	.....	1.85	1.5	1.8	1.75	.....	4.0

SAUQUOIT CREEK AT NEW YORK MILLS, ONEIDA COUNTY, N. Y.[a]

This stream rises in Oneida County and flows in a northerly direction, emptying into Mohawk River. It is shown in a part of its course on the Oriskany topographic sheet of the United States Geological Survey. Observations of flow are made at the dam which furnishes power to the upper, or No. 3, mill of the New York Mills.

The dam is of earth with plank facing, having a spillway 105.8 feet in length. The profile of the crest is somewhat irregular, and, in order to facilitate computation, has been divided into nine parts. Each part is assumed to have a horizontal crest line.

In the mill are two 27-inch Hercules turbines, which are run night and day a large part of the year.

During the summer but little water flows over the dam, the entire volume being used to drive the water wheels in the adjoining cotton mills.

The leakage of the dam was measured by current meter May 3, 1900, and found to be 5.6 second-feet.

This station was abandoned October 1, 1900.

[a] See Water-Supply and Irrigation Paper, U. S. Geol. Survey, No. 35, p. 48.

SAUQUOIT CREEK AT YORKVILLE, ONEIDA COUNTY, N. Y.

A continuous gaging record of Sauquoit Creek has not been maintained during 1901. Current-meter measurements have been made, as shown below, at the New York Central and Hudson River Railroad bridge, across the stream on Mohawk River Flats one-half mile above the mouth of Sauquoit Creek.

Principal developed water powers on Sauquoit Creek in 1901.

No. of dam from mouth of stream.	Location.	Name of mill or owner.	Manufacture.	Rated horsepower of water wheels.	Working head or fall, in feet.			Number of employees.		
					Greatest.	Least.	Average.	Men.	Women.	Total.
1	New York Mills.	The New York Mills, No. 4.	Hosiery, yarns, and corduroys.	266	30	27	28	.....	.....	.....
1	do	The New York Mills, No. 2.	do	500	30	28	29	.....	.....	.....
2	do	The New York Mills, No. 3.	Cotton cloth	300	18.5	17	18	.....	.....	.....
3	Capron	Utica Cotton Company.	Cotton fabrics and yarns.	100	21	21	21	160	90	250
[a] 4	New Hartford.	Divine Brothers	Buffing and polishing wheels.	25	.....	.....	6	20	30	50
[b] 4	do	New Hartford Knitting Mill.	Not operated	.....	.....	.....	9	.....	None	None
[c] 4	do	New Hartford Mills.	Custom milling	.....	.....	.....	12	3	None	3
[d] 4	do	New Hartford Cotton Manufacturing Company.	Unbleached cotton cloth.	120	20	20	20	60	80	140
[b] 5	Washington Mills.	Utica Tool Company.	Agricultural hand tools.	150	14	12	13	90	None	90
[e] 6	do	Washington Mills.	Textile mill abandoned.	100	.....	.....	11	None	None	None
[d] 7	Willowvale	Utica Willowvale Bleaching Company.	Bleaching and finishing.	None	.....	.....	9.5	135	135	270
[e] 8	do	J. C. Dewhurst	Carriage shop	.....	.....	.....	10	None	None	None
[f] 8	do	J. H. Rehm	Saw, grist, and cider mill.	80	.....	.....	10	2	None	2
[g] 9	Chadwicks	Chadwicks Mills Cotton Company.	Yarns, sheeting, and corduroy.	.....	22	22	22	65	60	125
10	Sauquoit	Lewis Knitting Cotton.	Cotton underwear	65	22	18	20	25	75	100
11	do	Sauquoit Valley Mills.	Flour, feed, and sawmill.	101	15	15	15	4	None	4
12	do	Polk's Knife Factory.	Farriers' knives	87	20	20	20	2	None	2
[h] 13	do	Adolph Seigel, Lower Mill.	Paper mill	None	20	20	20	None	None	None
[i] 14	do	Adolph Seigel, Upper Mill.	Pulp mill	None	24	20	22	15	None	15
15	Clayville	Alfred King	Foundry	50	15	15	15	.....	.....	.....
16	do	Empire Woolen Company.	Worsted and cashmeres.	80	26	24	25	175	120	55
17	do	do	Dam now used for storage only.	None	.....	.....	15	None	None	None
18	do	First National Bank, Utica.	No power in use.	None	.....	.....	15	None	None	None
19	do	Babbitt's Wire Works.	Line wire	114	30	30	30	.....	.....	.....

[a] Water used in four levels, total fall in power canal, 48 feet.
[b] Wheel not run.
[c] Dam failed, spring, 1901.
[d] Dam for water supply only.
[e] Not operated; first water privilege.
[f] Uses overflow or waste water at dam.
[g] Not in operation.
[h] Mill not operated.
[i] Dam destroyed; runs by steam.

Discharge measurements of Sauquoit Creek in 1901.

Date.	Gage height.	Discharge.	Hydrographer.
	Feet.	*Second-feet.*	
August 27	16.6	12.7	J. D. Luther.
August 29	16.2	24.2	Do.

The gage height given is the distance down to water surface from a bench mark on the top of the center brace of the upstream girder. The location of the bridge may be seen on the Oriskany sheet of the topographic atlas of the United States Geological Survey. The bridge is located below the lowest dam and water power on the stream. It is 2 miles below the gaging station formerly maintained at the upper New York Mills.[a] Owing to its rapid fall and favorable location near Utica, the available water powers of Sauquoit Creek have been developed to the fullest possible extent.

MOHAWK RIVER AT UTICA, ONEIDA COUNTY, N. Y.

A gaging station was established at the Genesee street bridge, across Mohawk River, at Utica, March 21, 1901.

The bridge has two spans of 83 and 72 feet. A vertical gage board in two parts has been secured to the downstream side of the central pier.

From Rome to Little Falls, a distance of 36 miles, Mohawk River flows through an alluvial valley, the stream channel being flanked by flood plains one-half mile or more in width. This flat valley is flooded to a depth of several feet during freshets. The intensity of floods at Little Falls is ameliorated in some degree by this extensive natural storage reservoir. During the navigation season the regimen of the stream above Utica is highly artificial. At Rome nearly the entire flow above the State dam is often diverted into Erie Canal, as is also the flow of Oriskany Creek, the principal tributary between Rome and Utica. There is also a certain amount of return water from waste weirs, some of which is brought through feeders to the canal from the adjacent watersheds of Black, Chenango, and Oneida rivers. The run-off from the tributary area, or 500 square miles above the Utica gaging station, is much less during the canal season than it would be from an equal area of the watershed without diversion.

Current-meter measurements of the flow at Utica station have been made as shown in the following table. The flood measurement of March 27, 1901, does not include a small amount of water which passed over Deerfield road, crossing the neck of the river bend, in the bow of which the gaging station is situated.

[a] See page 149.

Current-meter discharge measurements of Mohawk River at Utica in 1901.

Date.	Elevation of water surface.	Discharge.	Date.	Elevation of water surface.	Discharge.
	Feet.	*Second-feet.*		*Feet.*	*Second-feet.*
August 3	393.85	125	June 1	396.94	1,107
August 2	393.95	161	May 31	397.74	1,293
August 1	394.15	232	June 4	399.13	1,583
October 11	394.32	232	June 24	401.48	2,573
July 31	394.70	405	December 16	404.65	5,817
Do	394.75	465	March 27	406.12	10,888
May 11	396.18	736			

The elevation of the water surface at Utica during previous severe floods, with the corresponding discharge, estimated from a rating table deduced from the current-meter measurements, is given below, the elevations having been furnished by Stephen E. Babcock, C. E.

Estimated flood discharges of Mohawk River at Utica:

Date.	Elevation.	Estimated discharge.	Date.	Elevation.	Estimated discharge.
	Feet.	*Sec. feet.*		*Feet.*	*Sec. feet.*
Mean low water	394.64	355	High water, 1894	405.62	8,600
Freshet, Nov. 22, 1900	398.49	1,470	High water, 1895	406.32	11,900
Freshet, Nov. 27, 1900	405.44	8,000	High water, 1899	405.52	9,300
High water of 1890	405.68	8,800	High water, Mar. 27, 1901	406.19	11,100
High water, Feb. 26, 1891	407.22	17,300	High water, Dec. 15, 1901	406.75	14,300
High water, 1892	406.44	12,500			
High water, 1893	406.37	12,100			

From observations of slope, during the freshet of November 27, 1900, Mr. Babcock calculated the flood discharge of Mohawk River at Utica to be 12,643 second-feet.[a]

An aggregate of about 5 second-feet is diverted for water supply from Ballou, Starch Factory, and Reels creeks, three small tributaries entering Mohawk River just below the Utica gaging station. The location of the gaging station may be seen on the Utica atlas sheet of the United States Geological Survey.

Mean monthly run-off of Mohawk River at Utica, N. Y., for 1901.

[Drainage area, 500 square miles.]

Month.	Mean monthly flow in second-feet.	Run-off in second-feet per square mile.	Run-off in inches on drainage area.
April	1,932	3.86	4.32
May	643	1.29	1.48
June	1,076	2.16	2.42
July	312	.62	.71
August	189	.38	.43
September	325	.65	.73
October	375	.75	.86
November	503	1.01	1.13
December	1,655	3.31	3.82

[a] Engineer's Report to the Mohawk River Straightening Commission, Utica, N. Y., 1900, by Stephen E. Babcock.

Mean daily flow, in second-feet, of Mohawk River at Utica, N. Y., for 1901.

[Drainage area, 500 square miles.]

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	620	990	365	235	730	350	155	220
2	.....	575	1,155	280	210	540	415	220	395
3	2,160	620	1,325	265	165	570	440	.....	1,095
4	2,680	410	1,705	.....	135	900	340	140	745
5	3,450	385	905	340	130	450	270	130	485
6	3,050	320	555	760	135	180	200	105	485
7	2,300	270	2,160	895	160	.....	365	145	415
8	3,750	190	2,595	895	340	60	220	135	415
9	3,650	130	.....	365	65	60	210	305	515
10	3,150	75	1,685	315	235	95	160	245	2,000
11	2,530	785	730	270	470	140	510	245	2,385
12	2,420	1,890	620	305	340	350	510	345	2,510
13	1,980	.....	315	255	235	505	335	1,985	1,685
14	1,980	1,005	435	.....	160	455	1,295	1,455	1,990
15	1,785	605	410	245	165	.....	730	590	11,400
16	1,500	485	360	200	80	625	415	540	5,850
17	1,315	500	.....	235	175	515	335	485	5,100
18	1,215	510	.....	340	175	445	570	540	3,140
19	1,050	.....	385	255	160	365	730	555	2,080
20	1,035	660	565	210	165	260	490	485	1,050
21	990	550	1,520	.....	245	.....	420	455	760
22	1,360	435	2,080	135	180	135	370	425	520
23	1,915	1,065	2,550	155	145	140	305	455	635
24	1,720	920	2,510	130	175	120	270	415	658
25	2,060	520	1,380	125	200	.....	140	880	650
26	2,000	.....	580	135	190	85	140	1,020	555
27	1,700	435	460	135	145	.....	140	485	545
28	760	535	360	105	.....	70	165	1,045	515
29	705	920	365	200	125	70	155	340	530
30	650	1,340	340	440	.....	270	140	255	1,065
31	.....	1,240	.....	380	130	.....	.....	.....	930
Mean	1,932	643	1,076	312	189	325	375	503	1,655

WEST CANADA CREEK AT TWIN ROCK BRIDGE AND TRENTON FALLS, ONEIDA COUNTY, N. Y.

Twin Rock bridge crosses West Canada Creek 2 miles above Hinckley, practically at the point of emergence of the stream from the Adirondacks. The bridge is of iron, having two spans, and a length of 167.5 feet between abutments. The stream bed is of gravel and rock and the conditions are unusually favorable for a current-meter station. A gage board was set and a record commenced on September 7, 1900. The gage is read at 7 a. m. and at 6 p. m. each day, and the average of the two daily readings is given in the table on p. 154:

Current-meter discharge measurements of West Canada Creek at Twin Rock bridge.

Date.	Gage height.	Discharge.
1900.	*Feet.*	*Second-feet.*
September 7	0.45	182
1901.		
April 11	3.20	[a] 1,235
May 4	4.25	[a] 1,422
August 8	2.81	[a] 604
August 10	4.88	[a] 1,847

[a] Affected by backwater.

During April, 1901, an unusually heavy drive of logs produced a jam in the mill pond above Hinckley dam, 2 miles below the gaging station. This jam remained in position through the summer, and was carried out by high water December 15, 1901. The gage readings at Twin Rock bridge for this period are probably affected by backwater in some degree.

Black Creek enters West Canada Creek one-half mile above Twin Rock bridge. A discharge measurement of this stream at Grant, 2 miles from the mouth, showed the discharge to be 62 second-feet on August 8, 1901.

The record at Twin Rock bridge is kept by the Utica Electric Light and Power Company. This company has erected an electric-power plant at Trenton Falls, 4 miles farther downstream. A concrete dam has been constructed, and a head of 265 feet is obtained on the turbines, which are of special design.

The relative drainage areas tributary to the different gaging stations on West Canada Creek are shown below.

Drainage area of West Canada Creek.

Location.	Drainage area.
	Sq. miles.
At mouth	569
At Middleville	519
At Trenton Falls	375
At Twin Rock bridge	352

Daily gage height, in feet, of West Canada Creek at Twin Rock bridge for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.5	2.1	2.1	5.25	7.8	5.15	1.4	3.45	2.8	1.55	.55	1.6
2	1.5	2.1	2.1	5.4	7.5	4.65	1.3	3.45	2.85	1.42½	.55	2.0
3	1.5	2.1	2.1	5.11	6.95	5.25	2.1	2.3	2.72	1.6	1.85	2.05
4	1.5	2.1	2.1	4.1	6.2	4.4	1.55	2.0	2.55	1.42½	1.45	1.77½
5	1.5	2.1	2.1	4.3	3.45	5.55	1.5	2.25	2.35	1.45	2.15	1.62½
6	1.8	2.1	2.1	4.05	3.35	6.7	2.8	2.45	2.25	1.25	2.2	1.6
7	1.8	2.1	2.1	3.05	2.9	6.25	2.6	2.6	1.35	1.7	2.3	1.6
8	1.8	2.1	2.1	2.65	2.65	5.4	2.5	3.2	1.25	1.47	2.17	1.45
9	1.7	2.1	2.15	3.0	2.45	3.35	2.4	3.75	1.7	1.5	2.1	1.45
10	1.7	2.1	2.2	3.15	2.9	3.5	2.1	4.45	.60	.92	1.7	3.05
11	1.6	2.1	2.15	3.5	4.7	3.15	2.0	2.52	.57	1.2	1.85	4.25
12	1.6	2.1	2.1	3.3	5.6	2.75	2.52½	3.07	1.15	1.2	2.2	4.1
13	1.6	2.1	2.0	2.95	5.15	2.7	2.3	3.0	2.9	1.9	2.52	3.95
14	1.6	2.1	2.95	4.4	4.0	2.25	1.5	2.85	2.6	4.2	4.2	3.2
15	1.6	2.1	2.2	4.4	3.5	1.5	.70	2.5	2.3	3.4	4.2	15.45
16	1.55	2.1	2.4	4.15	3.1	1.5	.55	2.35	3.3	3.3	4.3	8.3
17	1.55	2.1	1.9	3.45	4.0	1.4	.50	2.22	2.9	3.1	4.15	8.95
18	1.6	2.1	1.95	3.35	4.35	1.4	2.9	2.22	2.5	2.75	4.1	6.4
19	1.6	2.1	1.75	4.5	4.0	1.5	2.6	1.75	2.55	2.62½	2.45	6.3
20	2.1	2.1	1.8	4.7	4.15	4.0	2.0	1.95	3.15	2.5	2.1	6.0
21	2.1	2.1	1.9	5.75	4.25	3.2	1.35	1.22	2.85	2.35	2.25	6.0
22	2.1	2.1	2.0	5.4	4.1	3.5	.7	1.2	2.25	2.3	1.85	3.3
23	2.1	2.1	2.65	5.2	4.1	4.65	.8	.925	2.05	2.1	1.75	2.4
24	2.1	2.1	2.85	5.6	3.2	3.5	.75	1.2	1.4	2.35	1.57	2.22
25	2.1	2.1	4.3	5.4	2.75	2.6	1.0	2.3	1.1	2.47	1.8	2.0
26	2.1	2.1	4.8	5.75	2.65	2.1	1.4	1.7	1.2	2.30	1.85	2.0
27	2.1	2.1	4.3	5.85	2.65	1.7	2.2	1.5	1.5	1.37	2.4	2.0
28	2.1	2.1	6.25	12.5	2.9	1.45	2.8	.70	1.4	1.32	2.0	2.0
29	2.1	2.1	5.3	11.85	4.0	1.3	3.95	.70	1.42	1.15	1.65	2.0
30	2.1	.....	5.0	8.75	4.15	1.5	4.35	.425	1.4	1.35	1.525	2.0
31	2.1	.....	6.05	.....	4.15	.....	3.15	.675	.....	.67	.....	2.0

Heavy rains on frozen ground December 15, 1901, caused a freshet discharge over the Trenton Falls dam estimated at 36,300 second-feet, or 96.8 second-feet per square mile.

It is probable that the intensity of this flood was increased to some extent by the failure of the Hinckley dam a short distance upstream. A high-water mark at Newport dam indicates a flood discharge for the freshet of August, 1898, of at least 22,000 second-feet, or 46.6 second-feet from the tributary drainage area of 472 square miles. In August, 1874, a freshet at Hinckley produced an estimated discharge of 21,100 second-feet, or 58.6 second-feet per square mile from the tributary drainage area of 360 square miles. The freshet of August, 1898, is estimated to have produced a discharge of 12,950 second-feet, or 24.9 second-feet per square mile at Middleville.

WEST CANADA CREEK AT MIDDLEVILLE, HERKIMER COUNTY, N. Y.[a]

Measurements of West Canada Creek have been made at Middleville, at the dam of the Nelson Knitting Company, which supplies power to four mills. The dam is of timber, with a nearly level crest, aside from the ice slide in the northern portion.

The principal element of uncertainty with this record in the past was considered to be leakage of the dam, etc., which had been taken at 50 second-feet. Current-meter measurements were made on September 10, 1900, to determine the leakage of the dam and the low-water flow of the stream at this station.

	Second-feet.
Highway bridge below dam, measured flow in main stream channel	113
Measured flow in hydraulic canal	132
Total flow from current-meter measurements	245

The calculated flow from the gage record gives the following results:

	Second-feet.
Flow over dam, gage reading 0.67	60
Leakage previously estimated	50
Total flow in main channel	110
Calculated diversion to water wheels	131
Total flow as estimated	241

The stream bed is of gravel and cobblestones. High water and ice have washed out deep holes below the toe of the dam, tending to increase the leakage. Measurements of the discharge below the dam in 1901 gave the following results:

Discharge measurements of West Canada Creek.

March 28:	Second-feet.
Metered flow in creek at highway bridge	4,559
Metered flow in power canal at highway bridge	154
Total flow past highway bridge	4,713
Metered discharge over dam	4,528
Estimated discharge of turbines	162

[a] See Water-Supply and Irrigation Paper, U. S. Geol. Survey, No. 35, p. 49.

	Second-feet.
August 10:	
Metered flow past highway bridge	965
Metered flow in power canal	96
Total flow past highway bridge	1,061
October 5:	
Metered flow in creek at highway bridge	480
Metered flow in power canal at highway bridge	28
Total flow past highway bridge	510
Flow over dam by meter	320
Flow over dam estimated	230
Difference, leakage, etc	90

As a result of this measurement, the leakage allowance for 1901, beginning May 1, has been increased 40 second-feet over the previous estimate.

Corrected daily flow, West Canada Creek, for November, 1900.

[For insertion, replacing former figures.]

Day.	Second-feet.	Day.	Second-feet.	Day.	Second-feet.	Day.	Second-feet.
1	593	9	1,164	17	460	25	3,245
2	463	10	1,149	18	464	26	6,103
3	410	11	756	19	722	27	5,837
4	328	12	738	20	1,550	28	3,068
5	420	13	586	21	3,087	29	2,150
6	491	14	583	22	2,796	30	1,794
7	505	15	575	23	2,496		
8	1,040	16	492	24	2,024	Mean	1,536

Mean daily flow, in second-feet, of West Canada Creek at Middleville, N. Y., for 1901.

[Drainage area, 518 square miles.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.
1	849	773	489	1,571	1,802	1,401	424
2	852	772	535	1,574	1,672	[a] 1,505	424
3	852	[a] 705	[a] 654	1,732	1,712	1,919	344
4	716	769	666	2,059	1,462	1,999	257
5	715	666	677	1,965	[a] 1,055	1,529	304
6	[a] 710	673	534	1,878	832	1,279	514
7	716	670	446	[a] 2,145	712	2,719	[a] 545
8	776	668	489	3,354	682	3,179	524
9	1,106	670	671	3,361	657	[a] 2,515	474
10	1,109	[a] 605	[a] 714	2,426	682	1,759	424
11	1,106	683	718	2,184	882	1,209	369
12	1,035	579	630	1,955	[a] 1,055	869	369
13	[a] 1,069	576	721	2,323	1,862	703	359
14	1,048	574	720	[a] 2,738	1,802	577	[a] 265
15	1,048	480	780	3,164	1,582	463	314
16	1,048	674	624	3,101	922	[a] 345	314
17	966	[a] 566	[a] 616	3,465	852	373	314
18	714	550	629	3,735	1,082	463	314
19	894	501	780	4,189	[a] 1,135	513	624
20	[a] 895	499	783	3,981	1,292	413	664
21	1,052	589	997	[a] 3,232	1,322	1,053	[a] 475
22	991	589	1,999	7,621	1,082	1,713	369
23	1,051	641	2,096	7,605	1,162	[a] 1,935	344
24	921	[a] 615	[a] 2,202	5,514	1,022	1,997	329
25	881	678	3,099	4,186	852	1,243	254
26	881	630	5,523	2,759	[a] 745	743	254
27	[a] 895	628	5,868	2,982	812	503	269
28	893	449	4,782	[a] 2,829	922	333	[a] 235
29	774	.....	.....	2,132	1,162	413	624
30	673	.....	.....	2,051	1,335	[a] 255	1,134
31	773	.....	([a])	.....	1,390	.....	1,464
Mean	871	624	1,330	3,167	1,114	1,197	488

[a] Sunday.

Mean monthly run-off of West Canada Creek at Middleville, N. Y.

[Drainage area, 518 square miles.]

MEAN MONTHLY FLOW IN SECOND-FEET.

Year.	1898.	1899.	1900.	1901.
January		1,150	1,366	871
February		1,594		624
March		1,176		1,330
April		3,365		3,167
May		1,456	924	1,114
June		397	406	1,197
July		324	451	488
August		235	463	
September		221	419	
October	1,161	324	448	
November	1,110	577	1,536	
December	1,024	1,259	800	

RUN-OFF IN SECOND-FEET PER SQUARE MILE.

January		2.21	2.63	1.68
February		3.07		1.20
March		2.26		2.57
April		6.48		6.12
May		2.80	1.78	2.15
June		.76	.78	2.31
July		.62	.87	.86
August		.45	.89	
September		.52	.80	
October	2.24	.62	.86	
November	2.14	1.11	2.97	
December	1.97	2.43	1.54	

RUN-OFF IN INCHES ON DRAINAGE AREA.

January		2.54	3.03	1.93
February		3.19		1.25
March		2.60		2.96
April		7.23		6.85
May		3.22	2.05	2.48
June		.85	.87	2.47
July		.71	1.00	.99
August		.52	1.02	
September		.58	.89	
October	2.58	.71	.99	
November	2.40	1.23	3.33	
December	2.27	2.80	1.77	

The lowest water in this stream occurs Sundays, when the flow is held back as pond storage by dams above Middleville. Aside from this, the most notable low-water period was September 2 to 12, 1899, inclusive, the mean flow at Middleville for eleven days being 183 second-feet, or 0.35 second-foot per square mile.

EAST CANADA CREEK AT DOLGEVILLE, HERKIMER COUNTY, N. Y.

This creek rises in Hamilton County and flows in a southerly direction between Herkimer and Fulton counties into Mohawk River at East Creek. A portion of the stream and drainage area is included on the Little Falls topographic atlas sheet of the United States Geological Survey. Observations are taken at High Falls, near Dolgeville, about 7 miles from the outlet of the stream. The gaging station is located at the dam of the Dolgeville Electric Light and Power Company. Readings of the depth on the crest are taken from a vertical gage board attached to the bulkhead 6 feet upstream twice each day by Henry F. Schuyler. The mean of the readings is used in computing the discharge. A record is also kept of the run-off, the water wheels, and the elevation of water in the tailrace.

The dam is of rubble masonry, 19 feet high, and has a flat crest 6 feet in width and 190.25 feet long between abutments. The elevation of the upstream edge of the crest is 1 foot below that of the lip. The impounded water is conducted to the power house, 500 feet below the dam, through a wrought-iron flume 10 feet in diameter. Prior to June 1, 1899, the discharge over the dam was computed from a discharge curve calculated by the use of coefficients derived from Cornell University Experiment No. 13.[a] The record since June 1, 1899, has been computed from a revised discharge curve based on Freeman's experiments on a model of the round-crested portion of the Croton dam, which apparently corresponds closely with the ogee section of the Dolgeville dam as regards friction on the crest, vertical contraction on the nappe, and siphonage.[b] The flow through the turbines for this period has also been computed from current meter measurements made in the tailrace of the electric power plant instead of from the manufacturers rating tables for the water wheels as formerly. The effect of these changes has been to slightly increase the extremes of flow, both as regards high and low water, the estimated flow for mean stages remaining substantially the same.

During October, 1901, pins were set in the crest of the dam, enabling flashboards to be put on. The dam is practically water-tight, and no allowance is made for leakage. The discharge over the flashboards is calculated by means of the Francis formula.

The turbines are of a special Victor cylinder gate type. The two main wheels are 36 inches in diameter each, and their speed is controlled by Lombard governors. The third wheel is 15 inches in diameter and drives the exciter. The following table shows the results of current-meter measurements made from a bridge across the tailrace below the power plant. Only one of the two 36-inch turbines was running in each instance, together with a 15-inch exciter wheel. The

[a] Water-Supply and Irrigation Paper, U. S. Geol. Survey, No. 35, p. 52.

[b] See report on New York's Water Supply, 1900, by John R. Freeman, C. E., p. 137.

latter runs at a sensibly constant width of gate opening at all times. The head on the wheels was 72 feet. Observations on the wheel-gate openings were taken at the beginning and end of each day, and the average is given in the table:

Gate opening at Dolgeville, N. Y.

Date.	Measured flow in tailrace.	Gate opening of 36-inch wheel.	Wheel number.
1900.	*Second-feet.*	*Inch.*	
May 22	84	0.50	2
July 27	76	.38	2
July 29	63	.28	1
August 9	80	.38	1

The following measurements of the total discharge of the stream, in comparison with the calculated flow, were also made:

Observed and calculated flow of East Canada Creek at Dolgeville, N. Y.

OBSERVED FLOW.

Date.	Flow over dam.	Flow in tailrace.	Total flow.
1900.	*Second-feet.*	*Second-feet.*	*Second-feet.*
May 22	328	84	412
July 27	376	76	452
August 7	[c] 28	80	108

CALCULATED FLOW.

Date.	Crest gage reading.	Flow over dam.	Flow in tailrace.	Total flow.
1900.	*Foot.*	*Second-feet.*	*Second-feet.*	*Second-feet.*
May 22	0.69	282	84	366
July 27	.79	362	84	446
August 7	.20	29	78	107

[c] Measured in stream channel above point of confluence with tailrace.

The total flow in the first two cases was measured at Dolgeville bridge, 1 mile above the dam. The difference between the observed and calculated flows, in the first instance, is probably due to pond storage. The accompanying table of mean daily flow shows the amount of water passing down the stream from the dam each day. The discharge of the stream at High Falls represents the total water yield of the tributary drainage area, with the exception of water diverted for the municipal supply of Little Falls and Dolgeville.

Spruce Creek is the principal tributary of East Canada Creek. It enters East Canada Creek 1 mile above Dolgeville and drains an area of 50 square miles. Water is diverted from this stream at Diamond Hill and from Beaver Creek, one of its tributaries, and is carried to Little Falls through a vitrified conduit 9 miles in length. The water supply of Dolgeville is taken from Cold Brook, a tributary of East Canada Creek. No allowance for diversion for water supply has been made in computing the run-off for East Canada Creek.

Just below the foot of Spruce Creek reservoir, at Diamond Hill, occurs a fall of 180 feet in about 2,000 feet. At Salisbury Center, farther downstream, occurs a second fall of 85 feet in 900 feet, a number of water-power privileges being developed at this point. There is a total of 12 dams on Spruce Creek, giving an aggregate fall of about 180 feet. East Canada Creek has a total fall of 445 feet from the mouth of the stream to the crest of the dam at Dolgeville. This includes a large amount of undeveloped fall. At Beardsley Falls, 2 miles from the mouth of the creek, occurs a natural descent of 105 feet in two short cascades over calciferous sand rock. The power at the lower fall is at present developed under a head of 57 feet. A masonry dam at the head of the upper fall 18 feet in height is being constructed, which will afford a total available head of 120 feet. Blue Falls, between Inghams Mills and Dolgeville, affords a natural descent of 30 feet and is undeveloped.

Principal developed water powers on East Canada Creek, 1901.

Number of dam from mouth.	Location.	Effective head.	Manufacture.
		Feet.	
1	East Creek	57	Generation of electricity.
2	Inghams Mills	10	Gristmill.
3	High Falls	72	Generation of electricity.
4	Dolgeville	20	Felt.
5	Stratford	.....	Sawmill; piano factory.

Flood discharge of East Canada Creek at Dolgeville.

Date.	Discharge.	Discharge per square mile.
	Second-feet.	*Second-feet.*
August 25, 1898	6,330	24.7
April 22, 1901	4,775	18.7
April 19, 1900	5,750	22.6
December 15, 1901	12,150	47.4

Mean daily flow, in second-feet, of East Canada Creek at Dolgeville, N. Y., for 1901.

[Drainage area, 256 square miles.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	306	957	158	957	686	787	219	162	[a]304	210	.....	[a]208
2	239	950	167	1,107	550	[a]892	201	162	275	213	([a])	275
3	205	[a]200	[a]216	1,272	446	934	179	128	332	327	.....	341
4	180	197	198	1,541	414	974	.....	[a]119	292	284	145	306
5	227	219	190	1,539	[a]372	749	.....	.....	244	234	145	268
6	[a]141	207	196	1,750	322	676	.....	.....	171	([a])	181	261
7	157	205	188	[a]2,373	.....	.....	([a])	356	136	192	173	222
8	180	205	226	2,470	.....	.....	321	270	[a]85	192	180	[a]256
9	199	205	216	2,545	.....	[a]1,342	267	220	97	192	165	271
10	199	[a]240	[a]264	2,416	.....	1,006	279	210	126	161	[a]91	886
11	197	197	278	1,791	292	804	226	[a]178	148	192	115	1,671
12	227	197	344	1,903	[a]250	632	214	226	244	192	523	1,291
13	[a]248	191	.....	2,725	1,233	518	192	194	352	([a])	1,231	936
14	307	166	.....	[a]2,817	994	446	[a]160	136	270	507	863	1,466
15	298	157	.....	2,783	767	414	161	162	[a]508	542	635	[a]9,990
16	287	148	.....	2,723	724	[a]308	159	414	454	483	490	2,301
17	329	[a]212	([a])	2,725	614	244	170	266	390	232	[a]517	1,326
18	281	189	200	2,860	614	232	161	([a])	350	312	590	911
19	281	189	382	2,723	[a]646	250	161	151	292	322	388	656
20	[a]306	209	364	2,605	944	566	143	162	220	([a])	388	591
21	241	217	556	[a]2,317	704	478	[a]120	162	220	282	404	506
22	239	197	765	4,775	614	478	91	210	[a]160	246	378	[a]340
23	239	189	804	3,475	686	[a]802	127	202	180	234	338	446
24	227	[a]200	[a]767	2,362	614	767	115	194	196	234	[a]318	391
25	239	166	1,104	1,683	614	517	115	[a]159	181	200	461	341
26	205	175	1,983	1,017	[a]508	390	127	160	167	192	386	336
27	[a]248	189	2,724	975	484	350	127	160	158	([a])	248	401
28	217	180	1,860	[a]882	478	292	[a]120	171	158	186	221	398
29	207	.....	1,514	843	688	268	137	138	[a]290	170	239	[a]598
30	197	.....	1,148	845	842	[a]244	193	153	478	154	271	385
31	239	.....	1,060	.....	886	.....	231	200	.....	128	.....	381
Mean	235	248	691	2,094	629	564	174	190	249	252	359	935

[a] Sunday.

Mean monthly run-off of East Canada Creek at Dolgeville, N. Y.

[Drainage area, 256 square miles.]

Month.	Mean monthly flow in second-feet.				Run-off in second-feet per square mile.				Run-off in inches on drainage area.			
	1898.	1899.	1900.	1901.	1898.	1899.	1900.	1901.	1898.	1899.	1900.	1901.
January	.....	816	531	235	.....	3.19	2.08	0.92	.....	3.67	2.39	1.06
February	.....	439	879	248	.....	1.71	3.43	.97	.....	1.77	3.56	1.01
March	.....	519	276	691	.....	2.03	1.08	2.69	.....	2.34	1.24	3.09
April	.....	1,978	2,086	2,094	.....	7.72	8.15	8.15	.....	8.65	9.12	9.12
May	.....	633	486	629	.....	2.47	1.90	2.45	.....	2.84	2.19	2.81
June	.....	196	370	564	.....	.76	1.44	2.20	.....	.85	1.60	2.45
July	.....	166	221	174	.....	.65	.86	.68	.....	.75	.99	.78
August	.....	97	144	190	.....	.38	.56	.74	.....	.43	.64	.85
September	638	92	133	249	2.49	.36	.52	.97	2.79	.40	.58	1.09
October	581	112	195	252	2.27	.43	.76	.98	2.61	.49	.87	1.13
November	689	377	957	359	2.69	1.47	3.73	1.40	3.01	1.64	4.18	1.56
December	564	706	368	935	2.20	2.72	1.44	3.65	2.53	3.13	1.66	4.20

The most notable low-water period was September 13 to 16, inclusive, 1899, the average volume of flow being 67 second-feet, or 0.3 second-foot per square mile, for four days.

Drainage areas of East Canada Creek.

Location.	Area.
	Sq. miles
Above High Falls	256
Above mouth	283

MOHAWK RIVER AT LITTLE FALLS, HERKIMER COUNTY, N. Y.[a]

This gaging station is located at the lower or Gilbert's dam, at Little Falls.

The dam is of masonry, having the form of a circular arc. It furnishes power for the Astoronga Knitting Mill and the Little Falls Paper Company's mills. In the Astoronga Knitting Mill there are installed two turbines, one 43 inches and the other 54 inches in diameter, built by T. H. Risdon & Co., Mount Holly, N. J. In the Little Falls Paper Company's mill are three Camden turbines and one 60-inch Day turbine, built in Little Falls.

Current-meter measurements have been made to check the calculated flows with very satisfactory results.

Current-meter measurements of Mohawk River at Little Falls, N. Y.

		Second-feet
October 20-21, 1898, at suspension bridge, 2 miles below Little Falls (W. D. Lockwood, hydrographer):		
Total flow by current meter		1,758
Computed flow (mean of two days)		1,733
May 1, 1900, at suspension bridge (R. E. Horton, hydrographer):		
Total flow by current meter		4,733
Computed flow over dam	4,060	
Computed diversion to Gilbert's mill	183	
Computed diversion to paper mill	556	
Total computed flow		4,799
May 23, 1900, at Astoronga bridge, Little Falls (R. E. Horton, hydrographer):		
Total flow by current meter		1,567
Computed flow over dam	950	
Computed diversion to Gilbert's mill	176	
Computed diversion to paper mill	405	
Total computed flow		1,531
Diversion to paper mill, September 19, 1900:		
Metered flow in headrace		302
Computed flow through turbines, etc		288
April 9, 1901, at suspension bridge (R. E. Horton, hydrographer):		
Total flow by current meter		10,095
Estimated flow at Little Falls		9,880

There are three dams at Little Falls. The lower two are used for water-power development. The upper one is a State dam, diverting water for the supply of Erie Canal. The gage record as kept at the lower dam shows the amount of water flowing downstream from Little Falls, but does not include diversion at the State dam above the gaging station, and hence does not represent the total yield or inflow from the tributary drainage area of 1,306 square miles.

[a] See Water-Supply and Irrigation Paper, U. S. Geol. Survey, No. 35, p. 51.

Current-meter measurements have been made in the feeder channel below the State dam as follows:

Current-meter measurements in feeder channel at Little Falls, N. Y.

Date.	Measured diversion.
1900.	*Sec.-feet.*
May 23	143
September 19	179

Mean daily flow, in second-feet, of Mohawk River at Little Falls, N. Y., for 1901.

[Drainage area, 1,306 square miles.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2,193	1,210	1,195	4,818	3,838	4,230	1,335	1,886	[a] 689	1,678	960	[a] 878
2	1,611	1,770	1,162	4,025	4,127	[a] 4,488	1,208	1,457	987	1,286	960	1,408
3	1,268	[a] 862	[a] 711	6,138	3,245	4,908	1,123	1,164	2,182	1,549	[a] 778	2,448
4	1,078	1,130	1,038	7,400	2,998	5,045	686	[a] 796	2,140	1,683	792	1,587
5	1,298	1,197	1,023	7,828	[a] 2,200	4,151	980	919	1,877	1,321	791	1,682
6	[a] 1,065	1,194	1,193	7,873	1,881	2,826	1,020	954	1,368	[a] 1,148	750	1,192
7	1,524	1,149	1,153	[a] 7,878	1,609	6,553	[a] 1,433	999	1,079	1,369	697	1,220
8	1,457	1,076	1,072	9,109	1,371	6,996	1,839	1,165	[a] 687	1,370	852	[a] 961
9	1,783	997	1,159	10,065	1,369	[a] 6,069	1,556	1,415	952	1,160	852	1,281
10	2,564	[a] 832	[a] 1,297	8,545	1,325	4,923	1,252	1,799	916	1,080	[a] 925	3,899
11	2,564	1,277	1,634	6,430	1,563	3,172	1,122	[a] 1,355	724	1,120	954	5,247
12	2,453	1,227	2,064	6,555	[a] 5,118	2,489	1,294	2,075	895	1,197	1,292	5,171
13	[a] 2,223	1,227	2,386	6,097	5,902	1,900	1,202	1,634	1,198	[a] 1,029	5,183	4,920
14	2,190	1,187	2,734	[a] 6,348	4,443	1,576	[a] 962	1,235	1,666	1,396	4,802	6,174
15	2,145	1,227	2,175	6,691	2,944	1,655	1,044	1,290	[a] 1,341	3,731	3,192	[a] 20,158
16	2,083	1,200	2,417	6,905	2,358	[a] 1,149	1,004	1,328	1,845	2,719	2,237	23,500
17	2,251	[a] 950	[a] 1,971	6,732	2,039	1,205	1,084	1,205	1,803	2,010	[a] 1,881	9,682
18	2,253	1,332	2,461	6,408	2,553	1,295	1,122	[a] 1,024	1,582	2,121	2,000	5,857
19	1,892	1,227	3,421	6,823	[a] 3,655	1,208	1,165	1,002	1,453	2,276	1,951	4,086
20	[a] 1,210	1,187	3,391	6,272	3,197	1,340	1,336	1,042	1,333	[a] 1,265	1,799	2,506
21	1,284	1,188	6,229	[a] 5,570	2,759	1,572	[a] 850	1,038	1,067	1,694	1,753	1,548
22	1,943	1,188	6,545	10,153	2,406	4,851	868	1,035	[a] 880	1,511	1,662	[a] 976
23	1,938	1,079	8,570	11,133	3,589	[a] 6,428	907	1,037	923	1,202	1,572	1,612
24	1,799	[a] 901	[a] 7,635	10,002	3,333	6,112	667	1,037	1,040	1,332	[a] 1,405	1,748
25	1,799	1,041	8,300	8,633	2,453	4,535	643	[a] 858	998	1,116	1,768	2,040
26	1,615	1,074	12,979	7,786	[a] 954	2,218	533	1,040	670	1,116	1,554	1,655
27	[a] 1,115	1,034	19,254	6,023	1,889	1,575	642	1,039	698	[a] 943	1,412	1,564
28	1,384	1,184	15,316	[a] 4,051	2,308	1,651	[a] 428	922	533	1,091	1,028	1,520
29	1,384	.....	10,297	4,412	3,051	1,420	956	826	[a] 705	1,091	1,114	[a] 1,552
30	1,301	.....	6,243	4,139	4,234	[a] 1,149	1,731	826	889	1,009	1,073	2,529
31	1,301	.....	[a] 5,759	.....	4,388	.....	2,862	775	.....	1,009	.....	2,476
Mean	1,741	1,125	4,574	7,061	2,871	3,290	1,124.32	1,167.06	1,150	1,471.68	1,599.63	3,970.23

[a] Sunday.

Mean monthly run-off of Mohawk River at Little Falls.

[Drainage area, 1,306 square miles.]

MEAN MONTHLY FLOW IN SECOND-FEET.

Year.	1898.	1899.	1900.	1901.
January		2,753	5,523	1,741
February		1,510	3,862	1,125
March		3,757	2,469	4,574
April		8,102	8,142	7,061
May		2,651	2,063	2,874
June		1,014	801	3,290
July		803	943	1,124
August		223	694	1,167
September	2,378	298	630	1,171
October	2,493	509	899	1,472
November	2,891	1,699	3,854	1,600
December	2,036	3,360	3,240	3,970
Year		2,223	2,760	2,597

RUN-OFF IN SECOND-FEET PER SQUARE MILE.

January		2.11	4.23	1.33
February		1.15	2.96	.86
March		2.88	1.89	3.50
April		6.20	6.23	5.41
May		2.03	1.58	2.20
June		.78	.61	2.52
July		.61	.72	.86
August		.17	.53	.89
September	1.84	.23	.48	.90
October	1.91	.39	.69	1.13
November	2.21	1.30	2.95	1.23
December	1.56	2.57	2.48	3.02
Year		1.70	2.11	1.99

RUN-OFF IN INCHES ON DRAINAGE AREA.

January		2.35	4.86	1.53
February		1.19	3.08	.89
March		3.32	2.18	4.02
April		6.92	6.95	6.06
May		2.34	1.82	2.53
June		.87	.68	2.82
July		.70	.83	.99
August		.19	.61	1.02
September	2.05	.25	.53	1.01
October	2.20	.45	.79	1.30
November	2.46	1.45	3.30	1.38
December	1.74	2.69	2.85	3.47
Year		22.72	28.48	27.02

Adding the amounts given in table on page 163 to the mean daily flow at Gilbert's dam, for the same dates, we obtain the following:

Total flow of Mohawk River at Little Falls, N. Y.

Date.	Total inflow at Little Falls.	Outflow in main channel.
1900.	*Second-feet.*	*Second-feet.*
May 23	1,596	1,453
September 19	693	514

While the record has been kept at Little Falls the following extreme freshets have occurred:

Extreme freshets at Little Falls, N. Y.

Date.	Discharge.	Discharge per square mile.
	Second-feet.	*Second-feet.*
April 15, 1899	13,000	10.0
April 20, 1900	15,240	11.7
November 27, 1900	15,669	12.0
March 27, 1901	19,538	14.9
December 16, 1901	26,280	20.1

The highest recorded previous flood occurred in February, 1891, The estimated discharge was 26,260 second-feet.

The most notable low-water period was August 3 to August 10, inclusive, 1899, the mean flow for nine days being but 120 second-feet, or 0.07 second-foot per square mile. This was due to the almost complete diversion of the run-off above to supply Erie Canal.

MOHAWK RIVER AT ROCKY RIFT DAM, HERKIMER COUNTY, N. Y.

Five-mile or Rocky Rift dam is a State dam used during the navigation season to divert water to Erie Canal. When the canal is closed the entire flow of Mohawk River passes over this dam. During the summer flashboards are maintained on the crest. These are carried off in the winter by ice and high water. The crest of the dam is straight and nearly level. The discharge during the high-water season of the winter of 1901 has been calculated from gage readings taken in connection with slope gagings of Mohawk River, described elsewhere. The flow over the crest has been calculated from experiments at Cornell University on a model dam of similar cross section. The maximum discharge recorded was on March 21, 1901, and is estimated to have been 23,150 second-feet, or 17.2 second-feet per square mile, from the tributary drainage area of 1,337 square miles.

Mean daily flow, in second-feet, of Mohawk River at Rocky Rift dam, New York, for 1901.

[Drainage area, 1,337 square miles.]

Day.	Feb.	Mar.	Apr.	Day.	Feb.	Mar.	Apr.	Day.	Feb.	Mar.	Apr.
1		760	4,460	12		1,840	7,580	23	900	8,270	13,920
2		760	4,750	13		1,840	5,460	24	900	7,940	15,400
3		620	6,730	14		1,840	7,580	25	900	890	9,360
4		415	6,730	15		1,950	7,060	26	900	13,280	6,900
5		415	9,940	16		2,100	6,140	27	900	17,340	6,380
6		415	7,740	17		1,950	6,730	28	900	16,460	5,160
7		620	8,420	18		2,920	6,560	29		10,319	4,800
8		900	8,780	19		4,430	6,560	30		7,580	4,460
9		900	9,160	20		4,430	7,060	31		5,170	
10		1,060	8,090	21		8,790	6,380				
11		1,840	7,240	22		8,610	10,300	Mean	900	4,537	7,528

Current-meter discharge measurements in the feeder channel below Rocky Rift dam gave the following results:

Current-meter measurements in feeder channel below Rocky Rift dam on Mohawk River, New York.

Date.	Flow in feeder.
	Sec.-feet.
November 3, 1900	236
May 3, 1901	203

CAYADUTTA CREEK NEAR JOHNSTOWN, FULTON COUNTY, N. Y.

Cayadutta Creek rises in Fulton County and flows into Mohawk River near Fonda. The dam of the Johnstown Electric Light and Power Company, 1 mile below Johnstown, where the record has been kept, is of framed timber, 33 feet in height, on a rock foundation. The impounded water is carried from above the dam to the power house through a 5-foot circular wooden flume.

The profile of the crest of the dam is somewhat irregular, and, for facility of computation, it has been divided into four parts, the crest line of each section being assumed horizontal. Since the establishment of the station standard sharp-crested gaging weirs have been erected for the company by Prof. O. H. Landreth. One of these weirs has been placed across the main stream above the head of slack water from the dam. A second weir has been placed in the tailrace below the power house. During the summer the water does not ordinarily flow over the dam, which is practically water-tight, the entire flow being passed through the turbines. A series of gagings at the tailrace weir has been made in order to determine the discharging capacity of the water wheels when running under different conditions, and calibration curves so obtained for the wheels have been used in calculating the later records.

Dams are located along the stream at frequent intervals, and the

amount of flow from one to another during the dry season is largely controlled by the runs of the water wheels. The drainage area tributary to Cayadutta Creek above the gaging station is 40 square miles, and above its mouth 62 square miles.

SCHOHARIE CREEK AT FORT HUNTER DAM AND AQUEDUCT, MONTGOMERY COUNTY, N. Y.

Schoharie Creek finds its origin in the western slope of the Catskill Mountains. The lower stretches of the creek flow through a long, flat valley in a stream channel covered with riprap, over which the water finds its way in a thin sheet during the dry season.

The State dam at Fort Hunter is near the mouth of the stream, and high water from the Mohawk backs up to the toe of the dam. A record of the elevation of water surface in the pond above the dam has been made. A similar record of the elevation of the water surface below the dam shows the average difference or fall to be 5.25 feet. This quantity is nearly constant except when the water falls below the crest level above the dam or when the height on the downstream side is affected by backwater. The dam is of timber backed with gravel, and there are a number of leaks above the gravel line at an elevation of 2 feet below that of the crest. During the summer, diversion through the canal feeder keeps the water level below that of the dam crest; hence the leakage of the dam represents practically the total inflow from Schoharie Creek to the Mohawk during the low-water season. Current-meter measurements of the leakage of the dam were made below the Erie Canal aqueduct at a point where the entire flow is concentrated in a narrow channel.

Current-meter measurements of leakage of dam made below Erie Canal aqueduct on Schoharie Creek.

Date.	Hydrographer.	Measured leakage.
1900.		*Second-feet.*
June 26	R. E. Horton	30
July 18	E. D. Walker	38
August 22	do	44

The leakage of the dam has been assumed constantly equal to 35 second-feet in computing the record. The Fort Hunter station was established September 24, 1898. The intention was to maintain a record of the water height above and below the head gates at the entrance to the canal feeder, from which the effective head on the gate openings could be determined and the flow computed by the formula for submerged orifices. During the dry season the water falls below the lip of the gates and flows in an open channel, making this method inapplicable. In recomputing the record, the diversion to

the canal feeder has been estimated from current-meter measurements, as follows:

Estimate of diversion to canal feeder at Fort Hunter, N. Y.

Date.	Hydrographer.	Measured flow in feeder.
1900		*Second-feet.*
June 21	R. E. Horton	112
July 18	E. D. Walker	76
August 22	do	73

Inflow to the Erie Canal is controlled by gates at the lower end of the feeder channel, so that the flow in the feeder is not directly a function of the stage of the water. Owing to the uncertainty of the low-water measurements, this station was abandoned July 31, 1900. It was again resumed October 1, 1900, and maintained during the winter in connection with the Barge Canal survey. The record for the winter months of 1900 and 1901, when no diversion to the canal took place, is included in the accompanying tables.[a]

The tables given show the total outgo from the pond above the State dam. As pointed out, the greater portion of this flow during the navigation season goes into Erie Canal. During the winter the entire flow is tributary to Mohawk River. A rough meter measurement above Fort Hunter dam April 24, 1900, showed the discharge to be 5,573 second-feet.

The Erie Canal crosses Schoharie Creek between Fort Hunter dam and Mohawk River. A gaging record was established at the aqueduct May 2, 1900, by Prof. Elton D. Walker. A current-meter measurement of the flow through the archways of the canal aqueduct made at that time showed a discharge of 1,257 second-feet; gage height, 2.26 feet. A similar measurement of the discharge at this point October 25, 1898, by W. D. Lockwood, gave a discharge of 1,015 second-feet. Owing to cross currents above the aqueduct, it was found impossible to secure reliable gagings, and the station was abandoned October 13, 1900. The locations of the Fort Hunter and aqueduct gaging stations are shown on the Fonda sheet of the United States Geological Survey.

Mean daily flow, in second-feet, of Schoharie Creek at Fort Hunter, N. Y., for 1900.

[Drainage area, 947 square miles.]

Day.	Nov.	Dec.	Day.	Nov.	Dec.	Day.	Nov.	Dec.	Day.	Nov.	Dec.
1		635	10		1,085	19		465	28	2,595	855
2		535	11		635	20		635	29	1,315	735
3		535	12		385	21	255	635	30	1,075	635
4		1,195	13		455	22	55	635	31		635
5		2,785	14		55	23	35	635			
6		1,885	15		315	24	255	635	Mean.	1,286	950
7		1,435	16		315	25		3,815			
8		1,315	17		315	26	635	2,785			
9		1,085	18		315	27	5,355	1,085			

[a] The tables of flow, as computed from the earlier portion of the record, allowing 315 second-feet for leakage, may be found in Water Supply and Irrigation Paper No. 25, p. 55.

Mean daily flow, in second-feet, of Schoharie Creek at Fort Hunter, N. Y., for 1901.

[Drainage area, 947 square miles.]

Day.	Jan.	Feb.	Mar.	Apr.	Day.	Jan.	Feb.	Mar.	Apr.
1	855	1,075	4,215	1,315	18	855	735	3,815	2,785
2	855	1,075	4,215	1,315	19	855	465	5,355	2,465
3	855	1,075	4,215	1,855	20	855	1,075	6,015	2,315
4	195	1,075	4,215	2,955	21	855	1,185	8,555	12,335
5	195	1,075	4,215	6,185	22	855	3,815	6,395	28,515
6	385	1,075	2,015	6,595	23	1,315	1,185	3,635	14,435
7	635	1,075	1,855	13,115	24	1,315	1,075	3,815	9,685
8	635	1,075	1,855	12,085	25	1,455	1,075	5,185	20,555
9	855	2,155	1,735	7,155	26	1,585	855	7,485	11,835
10	855	2,155	2,015	4,935	27	1,585	855	8,795	6,015
11	1,085	2,155	3,815	4,215	28	1,585	735	5,185	.....
12	1,185	2,015	8,555	3,635	29	1,315	.....	2,785	.....
13	1,315	1,855	4,935	3,815	30	1,175	.....	2,015	.....
14	1,315	1,315	3,815	3,635	31	1,075	.....	1,315	.....
15	1,315	1,315	4,215	3,435					
16	855	1,315	4,755	3,285	Mean	998	1,393	4,348	7,165
17	855	1,075	3,815	2,955					

SCHOHARIE CREEK AT MILL POINT, MONTGOMERY COUNTY, N. Y.

A current-meter station was established at Mill Point highway bridge on July 5, 1900. The stream bed is stony and fairly permanent. The channel is of nearly constant width at all stages of the stream.

Daily gage height, in feet, of Schoharie Creek at Mill Point, N. Y., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.65	2.20	2.15	2.20	2.60	3.25	.90	.70	.90	.65	1.05	1.25
2	1.60	2.10	2.15	2.00	.....	3.35	.85	.70	1.75	.70	1.00	1.5
3	1.55	2.20	2.15	2.10	.....	3.45	.80	.65	1.60	.75	.90	1.45
4	1.45	2.20	2.15	3.00	.....	3.05	.80	.60	1.50	.70	.90	1.55
5	1.40	2.20	2.15	4.02	.....	2.55	.75	.60	1.45	.65	.85	1.6
6	1.35	2.20	2.15	3.72	.....	1.95	.85	.60	1.30	.65	.85	1.6
7	1.45	2.20	2.15	6.25	.....	1.90	1.55	.55	1.25	.60	.80	1.55
8	1.40	2.20	2.15	6.75	.....	3.35	1.50	.70	1.1	.55	.75	1.5
9	1.40	2.20	2.20	4.50	.....	2.50	1.40	.75	1.0	.55	.75	2.0
10	1.45	2.15	2.20	3.65	.....	2.45	1.35	1.0	.8	.50	.70	3.37½
11	1.40	2.15	2.25	.....	.....	2.30	1.25	.95	.75	.45	.70	3.65
12	1.40	2.15	3.30	.....	3.10	2.05	1.20	.90	1.0	.40	.75	2.95
13	1.45	2.15	3.20	.....	3.58	1.80	1.20	.90	.9	.40	.95	2.5
14	1.40	2.15	2.80	3.20	2.80	1.50	1.20	.85	.85	2.50	1.0	3.6
15	1.50	2.15	2.10	3.25	2.35	1.35	1.15	.85	.85	2.30	1.0	11.7
16	1.75	2.15	2.00	3.30	2.15	1.35	1.10	.90	.85	2.10	1.1	5.1
17	1.80	2.15	1.75	3.20	2.35	1.35	1.10	.85	.95	2.00	1.15	4.1
18	1.85	2.15	1.60	3.25	2.50	1.30	1.30	.80	.9	1.90	1.15	2.8
19	1.80	2.15	1.85	3.20	2.70	1.25	1.65	.75	.85	1.80	1.20	2.0
20	1.90	2.15	2.10	3.25	2.80	1.20	1.55	.70	.85	1.80	1.30	2.0
21	2.05	2.15	3.82	7.60	2.75	1.15	1.35	2.07½	.85	1.80	1.25	1.95
22	2.10	2.15	4.67	8.30	2.50	1.00	1.15	1.45	.8	1.75	1.20	1.8
23	2.40	2.15	4.50	7.00	2.30	2.53	1.05	1.40	.8	1.40	1.15	1.8
24	2.30	2.15	4.15	7.75	2.20	2.50	.90	1.52½	.85	1.10	1.15	1.7
25	2.45	2.15	4.40	7.70	2.40	1.75	.85	2.20	.8	.85	1.10	1.7
26	2.30	2.15	4.70	.....	2.35	1.25	.80	1.85	.75	.70	1.0	1.6
27	2.40	2.15	5.50	.....	2.80	1.05	.70	1.60	.7	.70	1.0	1.55
28	2.40	2.15	4.79	3.10	3.35	1.00	.75	1.55	.65	.70	1.2	1.45
29	2.45	.....	2.90	2.90	3.20	.95	.70	1.35	.65	.70	1.3	1.40
30	2.40	.....	3.45	2.70	3.15	.90	.70	1.15	.60	.70	1.25	3.57½
31	2.35	.....	2.30	.....	3.05	.....	.70	1.00	.....	.90	.....	2.95

Current-meter measurements were made as follows:

Current-meter measurements at Mill Point, N. Y.

Date.	Gage height.	Discharge.	Hydrographer.
1901.	*Foot.*	*Second-feet.*	
July 5	0.64	87	E. D. Walker.
August 22	.47	141	Do.

The station was abandoned early in 1901, but was resumed temporarily in order to maintain a continuous record until repairs are completed at the Schoharie Falls station 1 mile upstream.

SCHOHARIE CREEK AT SCHOHARIE FALLS, MONTGOMERY COUNTY, N. Y.

A dam and power plant were erected by the Empire State Power Company, of Amsterdam, N. Y., at Schoharie Falls, 7 miles from the city of Amsterdam, in 1900.[a] A record of the stream was kept, beginning July 18, 1900. April 22, 1901, the record was temporarily discontinued during repairs of injuries resulting from high water of that date.

Soon after the completion of the dam, a weir of standard form was placed in an opening in the water-power canal embankment at a point where the entire flow of the stream could be concentrated so as to pass over the gaging weir. The weir had a sharp crest 25 feet in length, with two complete contractions, and the observations of flow given below were computed from the observed depth by means of the Francis formula.

Mean daily flow, in second-feet, of Schoharie Creek at Schoharie Falls, N. Y., 1900.

[Drainage area, 930 square miles.]

Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	87.75	43.9	25.7	74.7	1,000.8
2	.....	66.8	43.9	26.9	73.0	937.2
3	.....	57.9	41.95	25.3	68.1	983.5
4	.....	44.3	41.4	25.4	68.6	2,011.5
5	.....	38.2	50.4	25.1	68.7	1,901.0
6	.....	32.5	47.4	25.9	69.7	1,825.0
7	.....	36.2	42.7	28.0	71.15	1,788.7
8	.....	31.9	41.6	25.1	73.5	1,699.5
9	.....	24.9	35.9	25.7	82.0	1,511.8
10	.....	21.4	33.9	30.1	86.0	1,151.2
11	.....	21.4	32.95	31.2	86.1	939.6
12	.....	20.2	33.9	31.5	121.7	930.3
13	.....	24.9	33.8	32.15	214.5	913.2
14	.....	20.8	31.0	33.1	215.5	901.7
15	.....	20.65	30.1	32.4	213.6	891.5
16	.....	29.0	29.7	39.1	216.3	815.8
17	.....	592.9	28.0	41.7	224.1	809.2
18	105.6	344.2	27.8	36.95	235.7	811.7
19	96.65	294.9	27.3	35.2	273.0	813.1
20	87.7	153.0	26.2	35.7	319.7	859.8
21	209.4	101.3	25.0	37.2	615.1	954.6
22	123.3	96.7	23.9	36.8	607.1	1,074.1
23	118.2	96.5	23.7	52.0	581.5	1,150.1
24	114.6	87.6	23.8	53.6	593.0	1,588.5
25	127.5	72.3	24.9	53.5	609.1	4,205.5
26	114.85	66.1	21.4	52.4	952.1	3,701.5
27	115.2	60.7	20.8	72.1	1,858.1	3,252.5
28	105.6	57.6	24.9	69.7	1,652.0	2,852.6
29	98.7	53.3	24.9	70.7	1,465.5	2,251.7
30	87.7	57.6	31.0	67.9	1,021.5	938.5
31	87.9	50.4	.....	72.7	.....	935.7
Mean	110.0	89.16	32.27	40.35	427.0	1,526.0

[a] Described in Engineering Record, August 10, 1901, pp. 122-125.

Mean daily flow, in second-feet, of Schoharie Creek at Schoharie Falls, N. Y., 1901.

[Drainage area, 930 square miles.]

Day.	Jan.	Feb.	Mar.	Apr.	Day.	Jan.	Feb.	Mar.	Apr.
1	1,244	199	159	656	18	917	183	675	2,554
2	1,369	193	169	1,170	19	641	143	880	1,366
3	1,165	139	169	1,568	20	557	141	610	2,356
4	1,417	169	169	2,743	21	471	149	24,808	10,356
5	1,272	169	320	5,604	22	423	159	8,249	22,553
6	1,298	169	521	8,634	23	466	169	6,354	
7	1,183	169	649	15,643	24	553	149	4,255	
8	1,053	157	3,180	6,029	25	651	149	4,135	
9	1,002	149	451	4,952	26	680	169	4,811	
10	937	141	3,376	4,412	27	696	169	10,853	
11	1,044	127	1,239	3,717	28	556	169	3,605	
12	1,126	143	8,079	2,617	29	647		5,330	
13	1,377	161	5,220	2,470	30	562		1,148	
14	1,234	195	2,226	2,832	31	388		643	
15	1,006	165	1,375	3,002					
16	916	199	955	2,854	Mean	896	166	3,100	5,043
17	931	268	789	2,866					

Weir measurements of Schoharie Creek at Schoharie Falls.

Date.	Time.	Flow.	Date.	Time.	Flow
1901.		*Second-feet.*	1901.		*Second-feet.*
June 25	11 a. m.	86.2	June 29	5 p. m.	86.2
June 26	do	91.6	June 30	11 a. m.	92.9
Do	5 p. m.	91.5	Do	5 p. m.	92.9
June 27	11 a. m.	92.9	July 1	11 a. m.	92.9
Do	5 p. m.	92.9	Do	5 p. m.	91.5
June 28	11 a. m.	86.2	July 2	11 a. m.	91.6
Do	5 p. m.	91.5	Do	5 p. m.	92.9
June 29	11 a. m.	86.2	July 3	9 a. m.	93.4

From July 18 to December 31, 1900, the power plant was not in operation, and the entire flow of the stream passed over the main spillway of the dam. The discharge was computed by F. J. Lempe, C. E., by means of the Francis formula.

The dam is of masonry backed with timber. It has a flat crest 1 foot in width and a slope on the upstream face of approximately $2\frac{1}{2}$ to 1. The crest is 380 feet long. The elevation of the profile varies from 205.14 to 205.47 above datum. A discharge curve has been calculated by dividing the crest into six arbitrary sections, each assumed to be level. The coefficients of discharge used are those for a dam of similar cross section calibrated in Cornell University experiment No. 5.[a]

Adjacent to the dam is an overflow having a crest 50 feet in length. Water is conducted to the power plant through an open earth canal 3,900 feet long. The power canal terminates in a gatehouse, from which the water is fed to the turbines through two 150-foot steel penstocks, 8 feet internal diameter.

The power plant contains two pairs of 40-inch bronze bucket Leffel-Samson turbines in horizontal cases. The speed is regulated by means of Lombard governors, and the record includes the mean gate openings as shown by these governors, and the working head on water wheels.

[a] Trans. Am. Soc. Civil Eng., Vol. XLIV, p. 276.

A test was made of the discharge of pair No. 2 of turbines, April 5, 1901:

Working head on wheels	feet	35.61
Average gate opening during test	per cent of full opening	44.9
Discharge measurement by current meter in power canal	second-feet	216
Calculated discharge from manufacturer's rating table	do	210

The waste by leakage of canal banks, wheel gates, and penstocks has been estimated by Mr. Lempe as not more than 5 second-feet.

Excessive flood discharges at this station result from the breaking up of ice gorges formed farther upstream. During such a freshet on March 21, 1901, the water attained a depth of 11.2 feet on the crest of the dam, the calculated discharge being 49,600 second-feet, or 53.3 second-feet per square mile, from 930 square miles of tributary drainage area. April 22, 1901, heavy rains produced a freshet giving a discharge of 38,400 second-feet, or 41.3 second-feet per square mile.

Drainage areas of Schoharie creek.

Location.	Drainage area.
	Sq. miles.
At mouth	947
At Erie Canal aqueduct	946.8
At Fort Hunter dam	946.7
At Mill Point bridge	934
At Schoharie Falls dam	930

Mean monthly run-off of Schoharie Creek at Schoharie Falls.

[Drainage area, 930 square miles.]

Month.	Mean monthly flow in second-feet.		Run-off in second-feet per square mile.		Run-off in inches on drainage area.	
	1900.	1901.	1900.	1901.	1900.	1901.
January		896		0.97		1.12
February		166		.18		.19
March		3,400		3.61		4.15
April		5,043		5.44		6.09
May						
June						
July	110		0.12		0.14	
August	89		.10		.11	
September	32		.03		.03	
October	40		.04		.04	
November	427		.46		.51	
December	1,526		1.65		1.89	

MOHAWK RIVER AT SCHENECTADY, SCHENECTADY COUNTY, N. Y.

A current-meter station at Freeman's toll bridge, 1 mile below Schenectady, was established by Elton D. Walker, February 1, 1899.[a] A wire and weight gage is used; the scale is attached horizontally to the guard rail on the upstream side of the bridge and reads decimally from zero to 16 feet. A reading of the water stage is taken each morning by L. Diggins.

[a] See Water Supply and Irrigation Paper, U. S. Geol. Survey, No. 35, p. 55.

The bridge stands squarely across the stream. Its length between abutments is 417 feet. Three piers and crib foundations obstruct the channel, which has a depth in high water of 20 feet or more. The station is 2½ miles above the Rexford Flats dam, and the water levels are essentially the same at the two stations. The current is exceptionally smooth and uniform. The entire flow of the river passes under the bridge, except in time of very unusual freshets. The current is sluggish during low water, owing to backwater from Rexford Flats dam, and discharge measurements for minimum stages are considered less reliable than those for higher gage readings.

Current-meter discharge measurements, Mohawk River at Freeman's bridge.

Date.	Gage height.	Discharge.	Hydrographer.
	Feet.	*Second-feet.*	
July 17, 1900	[a]5.38	482	Elton D. Walker.
June 30, 1899	5.26	667	Do.
August 21, 1900	5.40	976	Do.
May 26, 1899	[a]6.22	2,092	Do.
May 12, 1900	6.50	4,135	Do.
June 13, 1901	6.55	4,448	J. D. Luther.
May 27, 1901	6.73	5,406	Do.
May 16, 1901	7.12	6,263	R. E. Horton.
April 3, 1899	[a]7.18	5,294	Elton D. Walker.
May 14, 1901	8.28	10,719	R. E. Horton.
April 4, 1901	9.92	18,473	Do.

[a] Meter No. 71, used in these measurements, needed rerating. Result subject to revision.

A discharge curve deduced from the meter observations has been used to reduce the gage readings to equivalent volumes of flow.

Mean daily flow, in second-feet, of Mohawk River at Schenectady, N. Y., for 1899.

[Drainage area, 3,321 square miles.]

Day.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.
1	4,620	10,300	7,620	12,140	.....	810	560	440	580
2	3,640	9,900	8,180	12,320	.....	730	520	500	1,840
3	3,010	7,800	7,440	12,810	.....	730	860	500	.....
4	3,010	6,720	6,360	13,700	.....	730	860	500	.....
5	3,010	9,700	8,940	7,440	.....	580	1,000	560	.....
6	4,960	([a])	7,510	6,000	.....	580	940	540	.....
7	3,010	([a])	16,400	4,960	.....	580	560	500	.....
8	3,010	13,920	([a])	4,440	1,260	730	560	560	.....
9	3,330	13,030	([a])	4,110	1,130	810	500	560	.....
10	4,620	10,500	17,860	3,480	1,070	2,070	500	460	.....
11	3,010	9,130	15,350	3,330	1,000	3,010	500	440	.....
12	2,410	8,330	([a])	3,330	940	2,640	520	440	.....
13	2,410	([a])	([a])	4,110	730	1,840	560	440	.....
14	2,410	([a])	([a])	4,270	680	1,260	560	420	.....
15	2,560	15,820	([a])	4,620	810	1,200	500	420	.....
16	2,700	12,590	([a])	4,440	730	1,130	460	420	.....
17	2,700	12,140	([a])	3,960	1,840	1,000	440	420	.....
18	2,700	8,560	([a])	4,550	1,890	1,840	460	420	.....
19	2,700	7,080	([a])	5,310	1,350	1,780	420	420	.....
20	3,170	11,300	([a])	5,930	1,070	1,400	460	420	.....
21	3,640	11,700	([a])	7,260	1,230	1,130	440	420	.....
22	5,480	9,320	([a])	6,900	2,410	1,130	440	420	.....
23	13,250	8,330	([a])	5,830	1,400	730	420	420	.....
24	13,220	8,750	([a])	4,550	1,130	630	440	420	.....
25	9,700	9,510	([a])	3,830	1,000	580	440	420	.....
26	8,560	8,560	([a])	3,390	1,000	560	440	1,410	.....
27	7,360	8,940	([a])	3,010	940	560	440	9,900	.....
28	10,100	6,900	18,300	2,860	810	560	460	3,800	.....
29	.....	6,360	16,060	3,330	940	560	420	2,410	.....
30	.....	8,750	13,300	4,960	860	580	440	1,980	.....
31	.....	6,830	.....	6,000	.....	500	440	.....	.....
Mean	4,792	9,659	11,941	5,715	1,140	1,050	534	1,133	1,210

[a] Exceeds limit of rating curve.

Mean daily flow, in second-feet, of Mohawk River at Schenectady, N. Y., for 1900.

[Drainage area, 3,321 square miles.]

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	7,440	1,260	580	940	860	560	1,400	8,940
2	.....	7,440	1,260	560	860	600	600	1,550	7,260
3	.....	6,360	1,260	580	600	580	560	1,490	6,000
4	.....	5,650	1,980	520	580	560	600	1,260	5,130
5	.....	5,310	1,660	500	600	440	560	1,130	12,810
6	.....	4,750	1,400	560	560	500	560	10,050	13,250
7	.....	4,110	1,550	560	500	580	420	860	10,300
8	(a)	3,330	1,000	560	520	500	440	940	9,700
9	(a)	4,110	1,550	600	440	520	520	3,950	8,560
10	13,250	4,960	4,110	860	440	420	440	6,180	6,900
11	10,420	4,960	6,000	1,000	440	440	440	4,620	5,130
12	9,320	4,270	1,980	860	440	500	520	3,170	3,170
13	10,700	3,480	1,550	780	440	440	500	2,270	4,960
14	10,300	3,010	1,400	730	500	440	600	2,120	5,480
15	8,940	2,860	1,260	730	600	440	500	1,980	3,330
16	10,120	2,700	1,260	680	3,480	440	520	1,840	2,700
17	11,700	2,860	1,130	700	2,410	420	560	1,660	2,270
18	(a)	2,700	1,050	560	2,120	440	560	1,260	2,560
19	(a)	2,560	860	580	1,610	420	1,050	1,550	2,410
20	(a)	3,010	580	860	1,130	420	860	2,120	2,700
21	(a)	4,270	600	860	1,000	440	560	5,830	3,170
22	(a)	3,330	600	1,000	780	440	560	8,180	3,330
23	(a)	3,010	860	1,840	600	440	520	1,080	3,010
24	(a)	2,560	580	1,490	560	1,840	560	6,000	3,010
25	(2)	2,410	560	1,070	600	1,350	680	4,960	4,960
26	15,590	1,980	560	940	680	1,130	3,170	11,620	9,700
27	12,140	1,840	520	3,170	580	860	2,700	(a)	4,620
28	10,700	1,400	560	2,860	560	540	1,840	(a)	6,290
29	8,640	1,260	580	1,890	600	680	1,660	(a)	4,960
30	7,620	1,130	560	1,400	560	580	1,980	11,700	3,960
31	.....	1,260	.....	1,260	1,130	.....	1,660	.....	3,480
Mean	10,726	3,562	1,336	1,005	866	609	896	3,621	5,614

[a] Exceeds limit of rating curve.

Mean daily flow, in second-feet, of Mohawk River at Schenectady, N. Y., for 1901

[Drainage area, 3,321 square miles.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3,640	2,560	1,550	10,500	8,790	9,320	1,400	3,010	1,130	1,550	860	1,400
2	3,800	2,120	1,400	8,560	7,440	10,100	1,260	2,410	1,550	1,660	860	1,550
3	2,700	1,660	1,260	8,750	7,260	11,300	1,260	1,840	3,490	1,980	730	3,010
4	2,120	1,550	1,400	18,300	6,720	10,820	1,130	1,400	3,490	1,660	600	4,440
5	3,010	1,550	1,660	(a)	5,310	9,130	1,130	1,000	3,330	1,840	730	6,540
6	2,120	1,260	1,840	(a)	4,270	7,080	1,260	860	2,860	1,550	730	2,560
7	1,980	1,400	1,980	(a)	3,480	11,500	4,110	1,000	2,120	1,490	680	1,980
8	2,410	1,260	1,840	(a)	3,010	(a)	3,640	1,260	1,660	1,260	600	1,692
9	2,120	1,550	1,660	(a)	2,700	13,220	3,010	1,260	1,260	1,260	680	1,692
10	2,560	1,660	1,980	(a)	2,410	10,100	2,270	2,120	1,130	1,260	560	2,124
11	3,640	1,400	3,640	17,860	3,330	7,990	1,840	2,270	1,260	1,130	730	(a)
12	2,960	1,836	6,180	14,870	8,520	5,830	1,840	3,170	1,550	1,000	1,000	17,080
13	4,890	1,660	7,800	14,160	11,930	4,620	1,780	2,860	1,550	1,000	1,400	13,698
14	3,700	1,550	6,000	13,920	11,500	3,800	1,550	2,120	2,120	2,120	6,900	9,700
15	3,330	1,660	5,650	11,160	8,520	3,490	1,260	1,840	2,410	5,480	5,480	(a)
16	3,080	1,400	6,540	14,400	6,320	2,700	1,130	1,840	2,560	6,900	3,960	(a)
17	3,010	1,840	6,540	13,480	4,960	2,270	1,130	2,120	2,860	4,620	4,750	(a)
18	3,640	1,660	6,180	13,120	4,750	1,980	1,260	2,120	3,800	3,490	2,700	15,824
19	3,450	1,400	7,260	13,480	7,620	1,660	1,840	1,660	3,170	3,010	2,560	10,900
20	2,700	1,550	9,510	12,590	8,180	1,780	1,660	1,260	2,860	3,170	2,410	8,560
21	3,960	1,660	11,220	14,160	8,330	1,550	1,660	1,000	2,560	2,640	2,010	5,481
22	2,560	1,830	(a)	(a)	6,720	3,640	1,490	2,410	1,660	2,270	2,010	3,799
23	2,410	1,550	(a)	(a)	5,650	8,560	1,130	3,800	1,400	2,180	2,120	4,782
24	3,330	1,400	18,300	(a)	6,900	9,900	860	2,120	1,130	1,980	1,840	3,642
25	3,010	1,260	13,700	(a)	6,720	9,790	1,000	2,410	1,130	1,660	1,660	4,270
26	2,700	1,400	(a)	(a)	6,000	6,360	860	3,010	1,050	1,400	2,860	4,443
27	2,500	1,130	(a)	18,300	4,960	3,330	730	2,410	860	1,260	3,010	3,642
28	5,030	1,400	(a)	13,250	5,480	2,410	600	1,840	780	1,260	2,860	3,799
29	3,960	.....	(a)	10,300	10,820	1,980	1,000	1,550	860	1,000	1,400	3,642
30	1,660	.....	16,300	8,750	10,100	1,660	1,130	1,260	1,130	1,000	1,550	4,443
31	2,410	.....	12,140	.....	10,900	.....	1,260	1,260	.....	1,000	.....	8,560
Mean	3,079	1,577	6,141	13,311	6,761	6,133	1,532	1,951	1,957	2,099	2,008	4,947

[a] Exceeds limit of rating curve.

Mean monthly run-off of Mohawk River at Schenectady.

[Drainage area, 3,321 square miles.]

MEAN MONTHLY FLOW IN SECOND-FEET.

Month.	1899.	1900.	1901.
January	.....	.....	3,079
February	4,792	.....	1,577
March	(a)	.....	(a)
April	(a)	(a)	(a)
May	5,715	3,562	6,761
June	1,140	1,336	6,133
July	1,070	1,005	1,532
August	534	866	1,951
September	1,133	609	1,957
October	1,210	896	2,099
November	.....	(a)	2,008
December	.....	5,614	4,947

RUN-OFF IN SECOND-FEET PER SQUARE MILE.

January	.....	.....	.93
February	1.44	.....	.48
March	(a)	.....	(a)
April	(a)	(a)	(a)
May	1.72	1.07	2.03
June	.34	.40	1.85
July	.32	.30	.46
August	.16	.26	.59
September	.34	.18	.59
October	.36	.27	.63
November	.....	1.09	.61
December	.....	1.69	1.48

RUN-OFF IN INCHES ON DRAINAGE AREA.

January	.....	.....	1.06
February	1.50	.....	.50
March	(a)	.....	(a)
April	(a)	(a)	(a)
May	1.98	1.23	2.28
June	.38	.45	2.07
July	.37	.35	.53
August	.18	.30	.68
September	.38	.20	.66
October	.41	.31	.72
November	.....	1.22	.68
December	.....	1.94	1.71

[a] Record incomplete. Discharges over 18,900 second-feet omitted.

Tables showing the daily gage height are given in connection with the slope gagings of Mohawk River, on page 184. Referring to pages 179 and 182, it will be seen that the three gaging stations on the Lower Mohawk, at Freeman's bridge, Rexford Flats, and Dunsbach Ferry, show close agreement in the monthly run-off. Differences which appear in the mean daily discharge on simultaneous dates may be attributed to pond storage, to diversion to Erie Canal at Rexford Flats, and to the fact that some time is required for water to travel from station to station.

Drainage areas tributary to Lower Mohawk River gaging stations.

Location.	Area.	Difference.
	Sq. miles.	*Sq. miles.*
Schenectady	3,321	.....
Rexford Flats	3,385	64
Dunsbach Ferry	3,440	55
Mouth of stream	3,468	28

MOHAWK RIVER AT REXFORD FLATS, SARATOGA COUNTY, N. Y.

This gaging station is located at the New York State feeder dam, 4 miles below Schenectady. The dam is of masonry with a timber apron. Experiments on a similar cross section were made at Cornell University to determine the proper coefficients of discharge.[1]

The accompanying tables of daily and monthly mean flow include the amount of water diverted for Erie Canal supply. They therefore represent the total inflow of Mohawk River to the pond above the dam, which is considerably greater than the amount which passes downstream from the dam during the season of canal navigation. The amount of diversion to the Erie Canal, prior to 1900, was assumed to be constantly equal to 128 second-feet during navigation months. Beginning with 1900, the diversion has been estimated by another method. Current-meter measurements of the flow in Rexford Flats feeder gave the following results:

Current-meter measurements in Rexford Flats feeder, New York.

Date.	Hydrographer.	Flow in canal feeder.
		Second-feet.
Oct. 27, 1898	W. D. Lockwood	128
June 25, 1901	R. E. Horton	272
April 4, 1901	do	[a] 19
May 15, 1901	do	226

[a] Leakage of feeder gates.

A comparison of these results with the mean monthly evaporation rate from a water surface for several years, as shown by records kept at Rochester, indicates that there is a nearly constant ratio between the water required for the canal and the mean monthly evaporation. The monthly diversion has been estimated from the above data, by proportion, for each month of the canal season as follows:

Monthly diversion from Mohawk River to Erie Canal at Rexford Flats, N. Y.

Month.	Mean evaporation.	Estimated diversion to canal.
	Inches.	*Second-feet.*
May	4.05	200
June	4.98	260
July	5.64	290
August	5.28	270
September	4.07	220
October	3.13	148
November	1.51	95

[1] See Trans. Am. Soc. Civil Eng., Vol. XLIV, p. 284.

The flow over the dam taken alone—that is, the amount of water passing downstream from Rexford Flats during the canal months—has been estimated as follows:

Flow over dam at Rexford Flats, N. Y.

Year.	1899.	1900.	1901.
	Second-feet.	*Second-feet.*	*Second-feet.*
May	3,956	2,657	6,146
June	1,886	1,243	6,408
July	370	1,157	1,540
August	166	1,476	1,050
September	752	761	1,775
October	1,480	536	811
November	2,696	8,335	1,995

The profile of the dam is quite irregular, and is divided into five sections, each assumed to be level for purposes of computation. The water has not fallen below the crest since the establishment of the station, and the profile of the dam obtained before the record was started has been used throughout. The leakage of the dam has not been estimated.

When ice from Schoharie Creek and other tributaries flows out, and occasionally during other freshets caused by rainfall, the water on the downstream side rises above the level of the crest of the dam. Experiments on the flow over a similar submerged weir are not available. The high-water flows have been taken from the discharge curve. The crest gages are situated about 50 feet upstream from the dam. At flood stages of the stream the water flows through the cross section opposite the gages with a relatively high velocity of approach. Owing to this fact and to the drowning of the dam by backwater the calculated flood discharges given below are considered as approximate only.

Estimates of flood discharges at Rexford Flats, N. Y.

Date.	Estimated discharge.	Discharge per square mile.
	Second-feet.	*Second-feet.*
Feb. 14, 1900	55,700	16.5
April 22, 1901	49,460	14.6
Dec. 15, 1901	54,250	16.0

A record of the area of opening of the gates in the guard lock at the entrance to the feeder, together with the effective head for the period from November 11 to December 9, 1900, showed the mean daily diversion for the last twenty days of November to be 92 second-feet and for nine days of December, to the closing of the canal, 105 second-feet.

Mean daily flow, in second-feet, of Mohawk River at Rexford Flats, N. Y., for 1900.

[Drainage area, 3,385 square miles.]

Day.	Oct.	Nov.	Dec.	Day.	Oct.	Nov.	Dec.	Day.	Oct.	Nov.	Dec.
1	468	1,545	8,195	12	428	3,085	.....	23	698	6,509	.....
2	448	1,295	6,286	13	468	2,230	.....	24	598	5,577	3,380
3	348	1,545	5,587	14	468	1,920	.....	25	598	5,344	4,550
4	348	1,495	5,121	15	598	1,765	.....	26	2,498	10,205	4,783
5	348	1,295	7,711	16	598	1,610	.....	27	2,498	24,180	5,016
6	348	1,295	11,835	17	598	1,610	.....	28	2,348	22,050	4,160
7	348	1,295	9,675	18	598	1,300	.....	29	2,198	15,095	3,965
8	348	1,295	8,921	19	468	1,362	.....	30	2,098	10,745	3,185
9	348	2,395	7,953	20	468	2,230	.....	31	1,848	.....	2,990
10	348	5,577	.....	21	598	6,043	.....				
11	348	3,865	.....	22	598	7,459	.....	Mean	784	8,440	6,066

Mean daily flow, in second-feet, of Mohawk River at Rexford Flats, N. Y., for 1901.

[Drainage area, 3,385 square miles.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3,380	1,360	1,360	9,058	7,082	12,261	1,523	1,657	1,196	856	803	1,672
2	3,185	996	1,360	8,090	6,849	12,261	1,523	1,440	1,609	856	803	1,672
3	2,990	906	1,360	8,332	6,849	10,101	1,523	1,298	2,074	856	803	1,672
4	2,290	870	1,515	15,960	7,082	7,625	1,523	1,244	2,074	856	803	1,672
5	2,042	780	1,670	19,220	5,484	6,908	1,523	1,154	1,702	856	863	1,672
6	1,825	870	1,670	20,920	4,985	6,442	1,523	1,154	1,299	856	803	1,982
7	1,825	906	1,670	26,275	4,752	9,831	4,486	1,244	1,299	856	803	2,168
8	1,515	1,112	1,515	32,800	4,050	15,581	4,096	1,267	1,299	1,036	803	2,447
9	1,453	1,205	1,515	23,375	3,660	13,161	3,706	1,267	1,196	1,036	803	2,664
10	2,445	1,205	1,825	19,220	3,192	11,451	3,121	1,154	1,196	946	803	6,742
11	3,185	1,205	2,600	15,320	2,802	10,641	2,763	1,154	1,106	856	803	9,935
12	3,380	1,515	5,016	13,500	7,324	9,077	2,143	1,064	1,106	856	821	8,911
13	3,263	1,267	5,715	12,600	9,260	7,625	1,771	974	1,454	856	1,001	7,701
14	2,795	1,205	4,783	12,300	7,566	6,036	1,678	794	2,229	856	1,207	10,745
15	2,990	1,515	5,016	12,300	7,324	3,992	1,678	794	2,229	1,942	3,163	40,865
16	3,185	1,515	5,249	12,300	7,451	2,365	1,678	1,064	2,694	4,347	6,043	44,350
17	3,380	1,670	5,249	11,730	4,985	2,210	1,368	1,595	3,052	5,397	8,185	21,600
18	3,770	2,290	5,249	11,460	6,150	2,117	1,676	2,122	3,364	3,177	6,975	11,460
19	3,185	1,825	6,181	10,920	7,566	1,807	1,926	1,502	2,974	2,717	3,553	4,355
20	2,795	1,670	8,090	10,920	7,808	1,807	1,833	1,244	2,694	2,159	2,447	3,185
21	2,600	1,825	9,058	12,000	6,849	1,807	1,523	1,244	2,539	1,384	2,261	2,507
22	2,873	1,670	24,085	10,380	6,383	3,095	1,319	1,244	8,550	1,036	1,672	2,197
23	2,990	1,515	15,320	33,210	6,383	8,593	1,265	1,244	2,043	946	1,091	2,073
24	3,185	1,267	15,640	26,650	6,150	9,319	1,085	1,064	1,578	946	1,207	2,414
25	2,990	1,205	15,960	32,410	5,218	7,625	1,085	1,064	1,578	946	1,982	3,107
26	2,445	1,050	27,400	30,460	4,985	6,447	995	1,657	1,268	946	2,447	2,678
27	4,783	1,050	35,670	16,920	5,218	3,797	905	2,277	1,178	946	3,358	2,383
28	3,575	1,205	28,900	14,700	5,917	2,520	1,265	1,967	1,088	946	2,968	1,887
29	2,678	.....	21,955	9,840	7,566	1,900	1,523	1,502	1,088	856	1,827	1,887
30	1,670	.....	12,600	7,848	8,776	1,652	1,523	1,244	1,088	856	1,672	2,678
31	.....	.....	10,650	.....	11,122	.....	1,771	1,244	.....	856	.....	3,692
Mean	2,822	1,299	9,221	16,701	6,348	6,668	1,830	1,320	1,995	1,059	2,090	6,931

Mean monthly run-off of Mohawk River at Rexford Flats, N. Y.

[Drainage area, 3,385 square miles.]

MEAN MONTHLY FLOW IN SECOND-FEET.

Year.	1898.	1899.	1900.	1901.
January		5,739	7,860	2,822
February		3,935	9,032	1,299
March		9,004	4,235	9,221
April		17,057	14,996	16,701
May		4,084	2,857	6,348
June		2,014	1,503	6,668
July		498	1,447	1,830
August		294	1,746	1,320
September		980	981	1,995
October		1,608	784	1,057
November		2,824	8,440	2,090
December	4,471	7,001	6,066	6,931
Year		4,587	4,996	4,857

RUN-OFF IN SECOND-FEET PER SQUARE MILE.

January		1.70	2.32	.83
February		1.17	2.67	.38
March		2.66	1.25	2.72
April		5.04	4.43	4.93
May		1.20	.84	1.87
June		.59	.44	1.97
July		.15	.43	.54
August		·09	.51	.39
September		.29	.29	.59
October		.47	.23	.31
November		.83	2.49	.62
December	1.32	2.07	1.79	2.04
Year		1.36	1.47	1.43

RUN-OFF IN INCHES ON DRAINAGE AREA.

January		1.96	2.67	.95
February		1.21	2.77	.40
March		3.06	1.44	3.14
April		5.62	4.94	5.52
May		1.38	.96	2.15
June		.66	.49	2.21
July		.17	.49	.62
August		.10	.58	.45
September		.32	.32	.66
October		.54	.26	.36
November		.92	2.79	.69
December	1.52	2.38	2.06	2.35
Year		18.32	19.77	19.50

The dates of opening and closing the canal, between which the record at Rexford Flats is affected by diversion to the feeder, have been as follows:

Dates of opening and closing Erie Canal.

Date opened.	Date closed.	Days open.
May 7, 1898	December 10, 1898	217
April 25, 1899	December 1, 1899	220
April 25, 1900	December 1, 1900	220
May 9, 1901	December 15, 1901	220

MOHAWK RIVER NEAR DUNSBACH FERRY, SARATOGA COUNTY, N. Y.

This gaging record is kept at the dam of the West Troy Water Company, one-fifth mile above Dunsbach Ferry bridge, 9 miles from the mouth of the river. The dam is in two sections, situated on opposite sides of a Hudson River shale island. The left wing at the upper end of the island has a crest length of 380 feet. The right wing, 500 feet downstream at the foot of the island, has a crest 280 feet long.

The record was established March 12, 1898, for the primary purpose of checking a system of levels for the United States Board of Engineers on Deep Waterways, by D. J. Howell, C. E., who has furnished the earlier portion of the record. No record was kept from April 1, 1899, to August 1, 1900.

The construction of the dam was begun in 1896. The lower wing was not completed until about October 1 of the summer of 1898. Openings existed in the dam prior to this date, making the computation of the record from March to September, 1898, impracticable.

In the pumping station adjoining the dam are two turbines of the old American type, one 66 inches and the other 75 inches in diameter. A current-meter measurement of the flow in the headrace leading to the wheel pit, October 17, 1901, showed the turbines to be using 200 second-feet, under an effective head of 6.7 feet, the rated discharge from the manufacturers' tables under the same head being 197 second-feet. These turbines usually run twenty-four hours each day at full-gate capacity. In computing the record, the discharge through the water wheels, when running, has been taken constantly equal to 200 second-feet. The turbines drive pumps taking water from the river for water-supply purposes at the rate of 1,500,000 gallons per day, equivalent to a continuous flow of 2¼ second-feet.

The dam is of masonry, with a flat granite crest 5.5 feet wide, standing 0.75 foot higher at crest lip than at the upstream edge. The average elevation of the crest of the upper section is 174.15 feet. The crest of the lower section has an elevation varying from 173.46 to 173.50 feet. The crest gage is attached to the timber cribbing 50 feet above the lower section of the dam, with its zero mark at an elevation of 172 feet, referred to the United States Deep Waterways datum. Gage readings are taken twice daily at intervals of about twelve hours by Edwin Conners. The mean of the two daily readings is used in

computing the flow. The discharge over the main dam has been calculated by means of the weir formula, using coefficients derived from Cornell University experiment No. 18,[1] representing an experimental cross section almost identical with that of the West Troy Company's dam. When the water rises to a height of 5 feet on the gage it begins to flow over the masonry headrace wall at the right-hand end of the lower section. This has a broad flat surface of rough masonry. The discharge over this portion has been computed from Cornell University experiment No. 12 on a flat-crested dam 6.56 feet wide.

During high water the current of the stream through the cross section of the channel leading to the lower dam has a velocity of several feet per second. The head due to this velocity has been added to the observed head as a correction for velocity of approach to the lower dam. The upper dam is situated 450 feet upstream from the crest gage. The loss of head from surface slope in this distance, as well as the velocity of approach to the upper section of the dam, are also corrected here. The elevations of the crest which have been used are those obtained by the United States Deep Waterways Survey. No allowance has been made for leakage of the dam or turbines, which is slight. The drainage area above the Dunsbach Ferry station is 3,440 square miles, or 55 square miles more than at Rexford Flats. Notable high-water discharges since the establishment of the record are tabulated below:

High-water discharges of Mohawk River at Dunsbach Ferry, N. Y.

Date.	Gage height.	Discharge.	Estimated discharge in second-feet per square mile.
	Feet.	*Second-feet.*	
March 14, 1898	8.5	[a]47,000	13.8
November 11, 1898	8.5	47,400	13.8
November 27, 1900	6.6	24,700	7.2
March 27, 1901	7.9	36,200	10.5
April 8, 1901	7.7	34,200	9.9
April 22, 1901	8.9	46,100	13.4
December 16, 1901	9.5	52,400	15.3

[a] Approximate.

Mean daily flow, in second-feet, of Mohawk River at Dunsbach Ferry, N. Y., for 1898.

[Drainage area, 3,440 square miles.]

Day.	Oct.	Nov.	Dec.	Day.	Oct.	Nov.	Dec.	Day.	Oct.	Nov.	Dec.
1	1,429	5,788	4,120	12	2,306	26,420	3,320	23	7,660	6,256	5,788
2	1,429	4,920	3,700	13	2,306	16,440	2,982	24	8,712	6,724	10,868
3	1,429	4,120	3,320	14	2,644	12,602	2,644	25	7,660	6,724	10,290
4	1,429	4,120	3,320	15	5,788	9,764	2,644	26	6,724	5,320	8,712
5	1,968	3,320	3,700	16	12,602	7,660	2,644	27	9,764	5,320	6,724
6	18,636	3,320	4,920	17	9,238	5,788	2,644	28	15,788	3,320	4,920
7	8,712	3,320	4,920	18	6,724	5,788	2,644	29	13,180	3,320	3,320
8	4,520	3,320	4,120	19	4,920	5,788	2,644	30	9,238	3,320	2,644
9	4,120	3,700	4,120	20	4,520	12,024	2,644	31	6,724		4,120
10	3,700	4,520	4,120	21	4,520	9,238	2,644				
11	2,644	41,200	3,700	22	4,920	6,724	3,320	Mean	6,321	8,007	4,252

[1] See Trans. Am. Soc. Civil Eng., Vol. XLIV, pp. 277–283.

Mean daily flow, in second-feet, of Mohawk River at Dunsbach Ferry, N. Y., for 1899.

[Drainage area, 3,440 square miles.]

Day.	Jan.	Feb.	Mar.	Day.	Jan.	Feb.	Mar.	Day.	Jan.	Feb.	Mar.
1	7,192	1,968	7,660	12	4,120	1,027	7,192	23	3,320	3,320	6,724
2	4,920	1,968	6,724	13	3,320	1,027	20,100	24	3,320	4,920	7,660
3	4,120	1,968	5,788	14	3,700	1,027	17,172	25	3,700	10,868	9,764
4	4,520	1,968	4,520	15	5,788	1,027	12,602	26	4,120	5,788	7,660
5	4,920	1,968	4,920	16	9,764	1,027	10,290	27	4,120	5,320	6,724
6	18,636	1,968	24,740	17	8,712	1,027	9,764	28	3,320	6,724	5,788
7	13,180	1,630	20,100	18	7,660	1,228	6,724	29	2,644	.....	5,788
8	9,764	1,429	12,024	19	6,724	1,429	5,788	30	2,366	.....	5,788
9	7,660	1,027	8,712	20	4,920	1,429	8,712	31	2,306	.....	5,320
10	5,788	1,027	8,186	21	4,120	1,968	9,764				
11	4,120	1,027	6,724	22	3,320	3,320	7,660	Mean	5,681	6,086	9,261

Mean daily flow, in second-feet, of Mohawk River at Dunsbach Ferry, N. Y., for 1900.

[Drainage area, 3,440 square miles.]

Day.	Aug.	Sept.	Oct.	Nov.	Dec.	Day.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1,228	1,027	625	1,429	6,490	18	1,968	457	1,027	1,328	2,644
2	1,027	1,027	625	1,429	6,256	19	1,429	289	1,027	1,429	2,982
3	826	826	625	1,429	5,554	20	1,228	289	1,027	1,630	2,982
4	625	625	625	1,328	5,320	21	1,027	373	926	5,320	2,813
5	826	625	625	1,228	12,024	22	1,027	457	625	7,660	2,644
6	625	457	625	1,027	12,024	23	625	625	625	6,720	2,982
7	625	457	625	926	9,764	24	625	1,630	625	5,120	2,982
8	541	457	541	1,027	9,764	25	625	1,429	625	4,520	4,720
9	457	541	457	1,328	8,712	26	1,027	1,027	2,475	8,186	8,975
10	457	625	373	5,554	6,256	27	1,027	1,027	2,475	23,900	6,490
11	457	625	383	3,700	4,320	28	826	1,027	1,799	22,760	5,554
12	457	1,027	457	2,982	3,320	29	625	625	1,529	16,440	4,720
13	457	373	457	2,475	4,320	30	625	625	1,630	10,290	4,120
14	541	373	457	1,799	4,120	31	1,027	.....	1,429	.....	3,700
15	1,027	373	541	1,630	3,700						
16	2,644	373	541	1,630	3,151	Mean	930	672	885	4,922	5,362
17	2,306	457	1,027	1,529	2,813						

Mean daily flow, in second-feet, of Mohawk River at Dunsbach Ferry, N. Y., for 1901.

[Drainage area, 3,440 square miles.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2,951	1,630	826	10,027	7,460	9,301	1,630	1,228	1,027	1,328	1,228	1,429
2	2,951	1,429	926	7,923	7,226	10,027	1,429	926	1,429	1,529	1,027	1,429
3	2,275	1,799	1,027	8,775	6,992	10,868	1,429	1,127	2,644	1,968	1,027	1,799
4	1,937	1,529	1,027	16,972	6,524	10,290	1,328	1,328	3,320	1,529	1,027	2,306
5	1,329	1,429	1,328	19,534	5,120	8,712	1,228	1,127	2,813	1,630	1,027	3,520
6	1,768	1,228	1,529	19,900	4,120	6,724	1,429	926	2,475	1,630	1,027	3,700
7	2,106	1,127	1,529	22,560	3,120	10,027	3,700	1,228	1,968	1,429	926	2,644
8	1,768	926	1,529	32,300	3,120	17,538	3,520	1,228	1,429	1,429	625	1,968
9	2,106	1,228	1,529	23,700	2,782	13,180	3,151	1,328	1,127	1,228	926	2,306
10	2,644	1,127	1,429	19,900	2,444	10,027	2,306	1,799	1,027	1,228	926	2,475
11	3,320	1,228	1,630	15,914	3,120	7,923	1,968	1,799	1,027	1,228	1,027	11,735
12	4,120	1,127	1,920	13,632	8,249	5,554	1,968	2,644	1,228	1,228	1,027	10,290
13	3,700	1,127	5,554	13,306	11,535	4,720	1,968	2,475	1,228	1,027	1,429	8,975
14	3,700	926	4,920	12,694	10,668	3,920	1,630	1,968	1,630	1,799	5,320	10,290
15	3,320	826	4,520	13,306	8,249	3,151	1,529	1,630	1,968	3,700	5,554	38,500
16	3,151	1,027	4,920	13,632	6,290	2,813	1,228	1,630	1,968	6,022	4,120	46,080
17	2,644	1,027	5,320	12,694	4,920	2,644	1,328	1,630	2,475	4,120	2,982	25,800
18	2,982	1,027	5,120	12,402	5,120	2,137	1,630	1,630	3,151	3,520	2,644	12,980
19	4,320	1,027	6,022	12,402	7,226	1,968	1,630	1,529	2,644	4,320	2,644	10,379
20	3,320	1,127	7,660	11,824	7,986	1,968	1,799	1,228	2,137	3,151	2,644	10,379
21	2,137	1,228	10,027	13,958	8,249	1,630	1,630	826	1,799	2,982	2,475	4,120
22	1,630	1,027	28,100	15,060	6,758	3,520	1,529	1,529	1,630	2,644	2,306	2,613
23	2,137	1,027	36,114	33,240	6,056	6,490	1,328	2,644	1,429	2,306	1,968	3,320
24	3,520	1,027	16,440	27,900	6,524	9,764	1,127	1,630	1,228	1,799	1,968	3,151
25	2,982	1,027	16,440	30,100	6,524	7,660	926	1,968	926	1,799	2,137	3,700
26	2,475	1,027	24,700	30,100	6,290	6,022	826	2,813	826	1,529	2,813	3,520
27	1,799	826	33,440	17,704	5,120	3,520	826	2,137	926	1,529	2,644	3,520
28	1,630	826	31,180	12,402	5,056	2,813	826	1,529	725	1,228	1,799	2,982
29	1,529	.....	23,140	9,827	10,668	2,306	1,328	1,328	926	1,127	1,429	3,151
30	1,799	.....	14,484	8,249	10,379	1,799	1,228	1,127	1,027	1,027	1,429	3,700
31	1,529	.....	12,024	.....	10,379	.....	1,228	1,027	.....	1,027	.....	6,958
Mean	2,567	1,141	9,332	18,068	6,622	6,300	1,633	1,580	1,672	2,066	2,004	8,055

Mean monthly run-off of Mohawk River at Dunsbach Ferry, New York.

[Drainage area, 3,440 square miles.]

MEAN MONTHLY FLOW IN SECOND-FEET.

Year.	1898.	1899.	1900.	1901.
January		5,681		2,567
February		6,068		1,141
March		9,261		9,332
April				18,068
May				6,622
June				6,300
July				1,633
August			930	1,580
September			672	1,672
October	6,321		885	2,066
November	8,007		4,922	2,004
December	4,252		5,362	8,055

RUN-OFF IN SECOND-FEET PER SQUARE MILE.

January		1.65		0.75
February		1.77		.33
March		2.69		2.72
April				5.26
May				1.93
June				1.83
July				.47
August			0.27	.46
September			.20	.49
October	1.83		.26	.60
November	2.33		1.43	.58
December	1.24		1.56	2.42

RUN-OFF IN INCHES ON DRAINAGE AREA.

January		1.90		0.86
February		1.84		.34
March		3.09		3.13
April				5.89
May				2.22
June				2.05
July				.54
August			0.31	.53
September			.22	.55
October	2.10		.30	.69
November	2.60		1.60	.65
December	1.43		1.79	2.79

MOHAWK RIVER SLOPE GAGINGS.

A series of gaging stations were established at various points on Mohawk River in 1900 with a view to determining the maximum high-water discharge and the downward progress of floods from the cross-section and surface slope. These stations were established under the direction of the State engineer and surveyor by the Barge Canal survey, D. J. Howell, consulting engineer. Gaging stations previously maintained by the United States Geological Survey were utilized as far as possible. On the completion of the investigations of the Barge Canal survey, the gage readings at the several stations were continued in connection with the measurement of the volume of streams.

A gage board was erected at each of the principal points of change of slope, whether occasioned by a dam or by the entrance of a large tributary. The stretch of the river extending between each two successive gages constitutes a slope section. The gage boards have been numbered consecutively from 1 to 24, beginning at the mouth of the stream. The elevations of the zero marks of the gages were determined by William B. Landreth, M. Am. Soc. C. E., Resident Engineer, Barge Canal Survey, from a line of precise levels referred to the Greenbush bench mark = 14.73, as a datum.

Mean daily elevation of water surface of Mohawk River at Cohoes Company's dam. Gage No. 1.

Day.	1900.			1901.			
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.
1		154.6	156.0	155.2	154.6	154.1	156.0
2		154.7	156.0	155.1	154.6	154.5	155.9
3		154.9	155.6	155.0	155.0	154.7	155.9
4		155.0	155.6	154.9	154.4	154.3	156.9
5		154.6	156.3	154.9	154.3	154.7	157.0
6		154.6	156.5	154.9	154.2	154.8	157.2
7		154.4	156.1	154.9	154.2	154.9	157.5
8		154.3	156.0	154.8	153.7	154.9	158.3
9		154.8	156.1	154.9	154.2	154.9	157.6
10		155.4	156.1	155.0	155.1	155.0	157.2
11		155.8	155.4	155.1	154.0	155.4	156.7
12		155.3	155.5	155.3	153.5	155.4	156.5
13		155.0	155.5	155.3	153.5	155.4	156.5
14		155.1	155.4	155.2	153.5	155.4	156.6
15		154.8	155.3	155.1	153.5	155.4	156.5
16		154.8	155.2	155.0	153.6	155.5	156.5
17		154.9	155.0	155.0	155.0	155.6	156.4
18		155.0	155.0	154.9	154.0	155.5	156.4
19		154.7	155.0	155.0	153.5	155.5	156.4
20		154.8	155.0	155.2	153.5	155.8	156.3
21		155.5	155.0	155.0	153.5	156.1	156.8
22		155.9	155.3	155.0	153.5	156.9	159.3
23	153.5	155.8	155.3	155.0	154.0	156.9	158.2
24	154.0	155.7	155.4	155.1	154.9	156.8	157.9
25	153.5	155.6	155.8	155.0	154.3	156.8	158.2
26	155.0	156.2	156.0	155.0	154.2	157.4	158.3
27	155.2	157.6	155.7	155.0	154.0	158.2	157.0
28	155.1	157.5	155.6	154.7	154.1	158.1	
29	154.5	157.0	155.4	154.7		157.4	
30	154.9	156.4	155.4	155.0		156.4	
31	154.8		155.3	154.8		156.3	

Mean daily elevation of water surface of Mohawk River below West Troy Company's dam. Gage No. 2.

Day.	1900.			1901.				
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.
1	.....	165.7	167.7	166.4	165.7	165.4	165.9	166.4
2	.....	165.7	167.2	166.4	165.7	165.4	166.9	.....
3	.....	165.7	167.1	166.1	165.6	165.4	167.8	.....
4	.....	165.7	167.0	165.9	165.6	165.4	166.2	.....
5	.....	165.6	168.4	165.9	165.6	165.6	166.5	.....
6	.....	165.5	168.6	165.8	165.6	165.7	167.0	.....
7	.....	165.4	168.0	166.0	165.5	165.7	166.6	.....
8	.....	165.5	167.9	165.7	165.5	165.7	165.4	.....
9	.....	166.1	167.7	165.7	165.6	165.7	166.3	.....
10	.....	167.1	167.3	166.0	165.6	165.7	166.9	.....
11	.....	166.7	167.0	166.4	165.6	166.3	166.2	.....
12	.....	166.3	166.9	166.5	165.6	166.7	165.1	.....
13	.....	166.1	167.1	166.4	165.6	166.9	165.1	.....
14	.....	166.0	166.7	166.3	165.5	166.7	165.2	.....
15	.....	165.9	166.4	166.3	165.5	166.6	165.2	.....
16	.....	165.9	166.2	166.2	165.5	166.7	165.2	.....
17	.....	165.8	166.1	166.2	165.6	166.8	165.1	.....
18	.....	165.7	166.1	166.3	165.6	166.8	165.2	.....
19	.....	165.7	166.2	166.5	165.5	167.2	165.2	.....
20	.....	165.8	166.2	166.4	165.5	167.7	165.2	.....
21	165.3	166.9	186.2	166.0	165.6	166.0	165.0	.....
22	165.3	167.5	166.2	165.8	165.5	.....	.....	.....
23	165.3	167.3	166.3	166.0	165.5	.....	.....	.....
24	165.3	167.1	166.3	166.3	165.5	.....	165.2	.....
25	165.3	166.8	166.8	166.1	165.5	.....	165.2	.....
26	166.2	167.7	167.9	166.0	165.5	.....	165.4	.....
27	166.1	170.8	167.4	165.9	165.4	.....	167.5	.....
28	165.9	170.4	167.2	165.8	165.4	.....	165.4	.....
29	165.8	169.3	166.7	165.8	.....	166.5	165.7	.....
30	165.8	168.3	166.5	165.8	.....	165.1	166.3	.....
31	165.8	.....	166.3	165.7	.....	165.5	.....	.....

Mean daily elevation of water surface of Mohawk River above West Troy Company's dam. Gage No. 3.

Day.	1900.			1901.				
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.
1	.....	174.6	176.0	175.2	174.7	174.3	176.7	176.2
2	.....	174.6	175.9	175.2	174.6	174.4	176.3	.....
3	.....	174.6	175.8	175.0	174.8	174.4	176.5	.....
4	.....	174.6	175.7	174.9	174.7	174.4	177.8	.....
5	.....	174.5	177.0	174.7	174.6	174.6	178.2	.....
6	.....	174.4	177.0	174.8	174.5	174.7	178.2	.....
7	.....	174.4	176.6	174.9	174.5	174.7	178.6	.....
8	.....	174.4	176.6	174.8	174.4	174.7	179.7	.....
9	.....	174.6	176.4	174.9	174.5	174.7	178.7	.....
10	.....	175.8	175.9	175.0	174.5	174.6	178.2	.....
11	.....	175.3	175.5	175.2	174.5	174.7	177.7	.....
12	.....	175.1	175.2	175.4	174.5	175.6	177.3	.....
13	.....	175.0	175.5	175.3	174.5	175.9	177.3	.....
14	.....	174.8	175.4	175.3	174.4	175.6	177.2	.....
15	.....	174.7	175.3	175.2	174.3	175.5	177.3	.....
16	.....	174.7	175.2	175.2	174.4	175.6	177.3	.....
17	.....	174.7	175.1	175.0	174.4	175.7	177.2	.....
18	.....	174.6	175.0	175.1	174.4	175.7	177.1	.....
19	.....	174.6	175.1	175.5	174.4	175.9	177.1	.....
20	.....	174.7	175.1	175.3	174.5	176.2	177.0	.....
21	174.4	175.7	175.1	174.9	174.5	176.7	177.4	.....
22	174.3	176.2	175.0	174.7	174.4	179.2	181.0	.....
23	174.3	176.0	175.1	174.9	174.4	177.7	179.8	.....
24	174.3	175.7	175.1	175.3	174.4	177.7	179.2	.....
25	174.3	175.5	175.6	175.1	174.4	177.7	179.5	.....
26	175.0	176.3	176.5	175.0	174.4	178.8	179.5	.....
27	175.0	178.7	176.0	174.8	174.3	179.8	177.9	.....
28	174.8	178.6	175.8	174.7	174.3	179.6	177.1	.....
29	174.7	177.7	175.6	174.7	.....	178.6	176.7	.....
30	174.7	176.7	175.4	174.8	.....	177.4	176.4	.....
31	174.6	.....	175.3	174.7	.....	177.0	.....	.....

Mean daily elevation of water surface of Mohawk River at Vickers Ferry. Gage No. 4.

Day.	1900.			1901.			
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.
1	.....	174.6	177.1	177.5	176.4	175.7	177.5
2	.....	174.6	176.6	177.7	176.3	175.7	177.0
3	.....	174.6	176.2	178.0	176.1	175.6	177.2
4	.....	174.6	176.1	177.6	176.1	175.7	179.5
5	.....	174.3	178.1	177.3	176.0	175.7	180.2
6	.....	174.3	178.2	177.2	176.0	175.8	180.3
7	.....	174.2	177.5	177.3	175.9	175.9	181.0
8	.....	174.2	177.3	177.2	175.8	176.0	183.2
9	.....	175.0	177.0	177.5	176.0	175.9	181.2
10	.....	176.1	177.0	177.5	176.1	175.9	180.3
11	.....	175.7	177.6	177.9	175.8	176.6	179.3
12	.....	175.3	177.3	178.0	176.1	177.5	180.2
13	.....	175.0	178.0	177.8	175.9	177.6	178.6
14	.....	174.9	178.0	177.8	175.9	177.2	178.6
15	.....	174.9	177.8	177.7	175.8	177.2	178.6
16	.....	174.8	178.1	177.6	175.9	177.4	178.7
17	.....	174.7	177.7	177.6	175.9	177.3	178.4
18	.....	174.6	177.7	177.5	175.9	177.4	178.3
19	.....	174.6	177.7	177.5	175.8	177.7	178.4
20	.....	174.8	177.7	177.5	175.7	178.4	178.3
21	.....	176.1	177.8	177.0	175.9	178.7	178.9
22	.....	176.7	177.7	176.9	175.9	182.2	186.5
23	174.2	176.5	177.7	177.0	175.8	179.6	183.4
24	174.2	176.1	177.7	177.4	175.7	179.5	182.2
25	174.2	175.9	178.4	177.3	175.7	179.5	182.5
26	175.1	177.1	179.5	177.0	175.7	181.6	182.7
27	175.2	181.0	178.8	177.0	175.7	183.5	179.7
28	174.8	180.8	178.5	176.5	175.3	182.9	178.4
29	174.6	179.5	178.0	176.4	.....	180.9	177.6
30	174.6	177.9	178.0	176.5	.....	178.8	177.1
31	174.6	.....	177.6	176.4	.....	178.1	.....

Mean daily elevation of water surface of Mohawk River at Rexford Flats. Gage No. 5, below dam.

Day.	1900.			1901.			
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.
1	.....	204.0	205.5	204.9	204.6	204.5	207.5
2	.....	204.2	205.4	204.8	204.6	204.5	207.7
3	.....	204.1	205.4	204.8	204.5	204.5	207.8
4	.....	204.1	205.2	204.7	204.5	204.5	206.8
5	.....	204.0	206.1	204.6	204.4	204.6	207.0
6	.....	204.0	206.0	204.6	204.4	204.5	207.1
7	.....	204.0	205.8	204.6	204.4	204.5	211.1
8	.....	204.1	205.7	204.4	204.4	204.6	210.2
9	.....	205.0	205.6	204.4	204.6	204.6	211.5
10	.....	205.5	.....	204.7	204.5	204.6	212.2
11	.....	205.2	.....	204.8	204.5	204.8	212.8
12	.....	204.9	.....	204.9	204.5	205.5	213.1
13	.....	204.8	.....	204.8	204.5	205.6	213.2
14	.....	204.6	.....	204.8	204.5	205.2	206.1
15	.....	204.6	.....	204.8	204.5	205.2	206.0
16	.....	204.6	.....	204.7	204.5	205.3	205.9
17	.....	204.6	.....	204.8	204.5	205.3	205.7
18	.....	204.5	.....	204.9	204.5	205.3	205.6
19	.....	204.6	.....	204.8	204.5	205.5	205.5
20	.....	204.8	.....	204.8	204.5	205.9	205.5
21	204.2	205.5	.....	204.8	204.5	206.1	206.0
22	204.2	205.7	.....	204.8	204.5	208.3	214.7
23	204.2	205.6	.....	204.8	204.5	206.7	212.5
24	204.2	205.3	204.7	205.0	204.4	206.5	212.0
25	204.1	205.3	204.8	204.9	204.3	206.6	212.6
26	205.0	206.0	204.9	204.8	204.3	209.3	210.8
27	204.9	208.8	204.8	205.4	204.3	.....	208.4
28	204.6	208.1	204.7	205.2	204.3	210.3	207.6
29	204.3	206.8	204.7	205.1	.....	208.3	207.1
30	204.2	205.9	204.8	204.7	.....	207.0	206.8
31	204.1	.....	204.8	204.6	.....	207.1	.....

Mean daily elevation of water surface of Mohawk River above State dam at Rexford Flats. Gage No. 6.

Day.	1900.			1901.			
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.
1	208.9	209.3	210.9	209.9	209.3	209.3	211.1
2	208.8	209.2	210.6	209.8	209.2	209.3	210.9
3	208.8	209.3	210.4	209.8	209.2	209.3	211.0
4	208.8	209.3	210.3	209.6	209.2	209.3	212.4
5	208.8	209.2	210.8	209.5	209.1	209.4	212.8
6	208.8	209.2	211.5	209.4	209.1	209.4	213.0
7	208.8	209.2	211.2	209.4	209.1	209.3	213.8
8	208.8	209.2	211.0	209.3	209.3	209.3	214.6
9	208.8	209.9	210.8	209.4	209.4	209.3	213.3
10	208.8	210.4	.....	209.6	209.2	209.4	212.8
11	208.8	210.0	.....	209.7	209.2	209.6	212.2
12	208.8	209.8	.....	209.8	209.3	210.3	212.0
13	208.9	209.6	.....	209.8	209.3	210.4	211.7
14	208.9	209.5	.....	209.7	209.3	210.2	211.7
15	209.0	209.3	.....	209.7	209.4	210.2	211.7
16	209.0	209.4	.....	209.8	209.4	210.3	211.7
17	209.0	209.4	.....	209.9	209.4	210.3	211.6
18	209.0	209.2	.....	210.0	209.6	210.3	211.6
19	208.9	209.3	.....	209.9	209.5	210.5	211.5
20	208.9	209.5	.....	209.8	209.4	210.9	211.5
21	209.0	210.5	.....	209.7	209.5	211.1	211.8
22	209.0	210.8	.....	209.8	209.4	213.4	216.4
23	209.0	210.6	.....	209.7	209.5	212.2	214.7
24	209.0	210.3	210.0	209.8	209.3	212.3	213.9
25	209.0	210.3	210.2	209.8	209.2	212.3	214.6
26	209.8	211.3	210.4	209.6	209.2	213.9	214.4
27	209.8	213.4	210.3	210.3	209.2	215.0	212.4
28	209.7	213.2	210.2	210.3	209.2	214.2	211.5
29	209.6	212.2	210.1	209.6	.....	213.0	211.2
30	209.5	211.4	209.8	209.3	.....	211.8	210.8
31	209.4	.....	209.8	209.2	.....	211.4	.....

Mean daily elevation of water surface of Mohawk River at Schenectady, N. Y. Gage No. 8.

Day.	1900.			1901.						
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.
1	209.0	209.3	211.6	210.1	209.7	209.4	212.0	211.5	211.7	209.3
2	209.0	209.4	211.1	210.1	209.5	209.3	211.5	211.2	211.9	209.3
3	209.0	209.3	210.8	209.8	209.4	209.3	211.5	211.1	212.2	209.3
4	209.0	209.3	210.5	209.6	209.4	209.3	213.8	216.0	212.0	209.2
5	209.0	209.2	212.5	209.9	209.4	209.4	214.4	210.6	211.6	209.2
6	209.0	209.2	212.6	209.6	209.3	209.5	214.5	210.3	211.1	209.3
7	208.8	209.1	211.9	209.5	209.3	209.5	215.3	210.0	212.2	210.2
8	208.9	209.1	211.8	209.7	209.3	209.5	217.7	209.9	213.9	210.1
9	208.9	210.2	211.5	209.6	209.4	209.4	215.3	209.8	212.6	209.9
10	208.9	210.8	211.0	209.7	209.4	209.5	214.5	209.7	211.9	209.6
11	208.9	210.4	210.5	210.1	209.3	210.1	213.6	210.0	211.3	209.5
12	208.9	209.9	209.9	210.2	209.5	210.8	213.0	211.5	210.7	209.5
13	208.9	209.6	210.5	210.4	209.4	211.3	212.8	212.3	210.4	209.4
14	209.0	209.6	210.6	210.1	209.4	210.8	212.8	212.2	210.1	209.4
15	208.9	209.5	210.0	210.0	209.4	210.7	212.8	211.5	210.0	209.3
16	208.9	209.5	209.8	209.9	209.3	210.9	212.9	210.9	209.8	209.2
17	209.0	209.4	209.6	209.9	209.5	210.9	212.7	210.5	209.6	209.2
18	209.0	209.3	209.7	210.1	209.4	211.8	212.6	210.4	209.5	209.3
19	209.2	209.4	209.7	210.0	209.3	211.1	212.7	211.2	209.4	209.5
20	209.1	209.6	209.8	209.8	209.4	211.7	212.5	211.4	209.4	209.4
21	209.0	210.7	209.9	210.2	209.4	212.1	212.8	211.4	209.4	.....
22	209.0	211.4	210.0	209.7	209.5	216.2	220.4	211.9	210.1	.....
23	209.0	211.1	209.9	209.7	209.4	214.6	217.3	210.7	211.5	.....
24	209.0	210.8	209.9	210.0	209.3	213.8	216.3	211.0	211.8	.....
25	209.0	210.5	210.5	209.9	209.3	213.7	217.0	211.0	211.3	.....
26	209.9	212.2	211.8	209.8	209.3	216.0	217.0	210.8	210.9	.....
27	209.8	215.4	211.4	209.7	209.2	217.3	213.8	210.5	210.0	.....
28	209.5	215.1	210.8	210.5	209.3	217.2	212.6	210.6	209.7	.....
29	209.4	213.8	210.5	210.2	.....	215.3	211.9	212.0	209.5	.....
30	209.5	212.3	210.2	209.4	.....	213.3	211.5	211.9	209.4	.....
31	209.4	.....	210.0	209.7	.....	212.4	.....	212.1	.....	.....

Mean daily elevation of water surface of Mohawk River at Hoffmans Ferry. Gage No. 9.

Day.	1900.			1901.			
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.
1	.....	235.3	239.4	237.1	235.8	235.5	239.8
2	.....	235.5	238.7	236.8	235.7	235.4	239.0
3	.....	235.4	238.3	236.4	235.7	235.4	240.0
4	.....	235.1	238.0	235.9	235.6	235.5	242.1
5	.....	235.0	241.6	235.8	235.5	235.7	243.3
6	.....	234.8	240.7	236.2	235.8	236.3	243.2
7	.....	234.8	240.1	236.1	235.9	236.3	244.8
8	.....	235.6	239.9	236.0	236.1	236.0	245.8
9	.....	238.1	238.4	236.2	236.1	235.8	244.6
10	.....	238.1	238.3	236.4	236.2	236.4	242.9
11	.....	237.2	237.5	237.4	236.3	237.7	241.9
12	.....	236.5	237.2	237.4	235.9	238.9	241.5
13	.....	236.1	237.3	237.2	236.2	238.9	241.1
14	.....	235.9	237.3	237.2	236.7	238.3	241.3
15	.....	235.9	237.8	236.9	236.4	238.2	241.4
16	.....	235.7	238.6	236.7	236.5	238.9	241.3
17	.....	235.4	238.2	236.6	235.9	239.1	241.0
18	.....	235.3	238.0	236.6	235.7	238.5	240.9
19	.....	235.4	238.0	236.6	235.7	239.9	241.0
10	.....	236.5	238.2	236.6	235.6	240.5	240.8
21	.....	239.1	238.3	236.3	235.7	241.1	242.4
22	.....	239.1	238.1	236.2	235.6	245.2	243.8
23	.....	238.7	237.7	237.0	235.6	241.7	246.7
24	234.4	238.0	237.5	236.9	235.7	242.1	244.9
25	235.3	237.5	340.7	236.6	235.6	242.0	246.6
26	236.7	241.6	239.9	236.2	235.3	245.2	244.6
27	236.1	244.7	239.4	236.0	235.6	246.8	242.2
28	235.5	244.0	238.4	236.0	235.6	245.7	240.5
29	235.6	241.8	237.8	235.9	.....	243.6	239.9
30	235.7	240.2	237.4	236.0	.....	241.3	239.4
31	235.5	.....	237.0	235.9	.....	240.5	.....

Mean daily elevation of water surface of Mohawk River at Amsterdam. Gage No. 10.

Day.	1900.			1901.			
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.
1	.....	248.2	251.3	250.3	250.4	249.8	251.7
2	.....	248.8	250.8	250.2	250.3	249.8	251.2
3	.....	248.8	250.5	251.4	250.3	249.8	251.9
4	.....	248.4	250.4	251.6	250.2	250.0	253.4
5	.....	248.5	253.0	251.2	250.1	250.1	254.5
6	.....	248.5	252.2	251.4	250.2	250.3	254.7
7	.....	248.5	251.8	251.3	250.1	250.2	256.2
8	.....	248.6	251.6	251.2	250.3	250.1	257.1
9	.....	250.5	251.3	251.3	250.2	250.3	255.3
10	.....	250.4	250.6	251.6	250.3	250.4	254.3
11	.....	249.9	250.3	252.2	250.2	251.4	253.3
12	.....	249.4	250.1	251.9	250.2	252.4	253.0
13	.....	249.2	250.0	251.9	250.1	252.3	252.7
14	.....	249.2	249.9	251.6	250.2	252.1	252.8
15	.....	249.1	249.9	251.3	250.1	251.9	252.9
16	.....	249.1	249.9	251.2	250.1	252.4	252.8
17	.....	248.9	250.3	251.1	250.0	252.4	252.6
18	.....	248.9	251.9	251.3	250.0	252.4	252.5
19	.....	249.0	252.0	251.1	250.0	253.4	252.5
20	.....	249.7	252.0	250.9	250.1	254.2	252.4
21	.....	251.2	251.9	250.5	250.1	254.8	254.9
22	.....	251.2	251.8	250.7	250.0	260.7	260.6
23	.....	250.9	251.6	251.1	250.0	257.0	258.4
24	248.3	250.4	251.4	251.4	250.0	254.7	256.1
25	249.1	250.1	253.4	251.0	249.9	254.0	257.6
26	249.6	253.3	252.8	251.5	249.8	256.1	255.6
27	249.2	256.3	252.4	251.0	249.9	258.3	253.6
28	248.9	255.3	251.7	250.5	249.9	257.8	.....
29	248.9	253.3	251.3	250.6	.....	254.8	.....
30	248.5	252.1	250.9	250.5	.....	252.7	.....
31	248.8	.....	250.4	250.4	.....	252.3	.....

Mean daily elevation of water surface of Mohawk River at Fort Hunter. Gage No. 13.

Day.	1900.			1901.			
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.
1	.....	267.9	269.9	269.2	269.4	269.4	270.4
2	.....	267.8	269.6	269.2	269.4	269.4	270.0
3	.....	267.7	269.3	269.2	269.4	269.4	270.5
4	.....	267.7	269.9	269.2	259.4	269.4	271.8
5	.....	267.7	271.5	269.2	269.4	269.4	272.6
6	.....	267.6	270.5	269.4	269.4	269.4	272.7
7	.....	267.6	270.4	269.4	269.4	269.4	273.6
8	.....	267.7	270.3	269.4	269.4	269.4	274.1
9	.....	269.5	270.2	269.4	269.4	269.4	273.2
10	.....	269.3	269.3	269.4	269.4	269.4	272.5
11	.....	268.7	269.3	269.4	269.4	269.7	272.4
12	.....	268.3	269.1	269.4	269.4	271.4	272.0
13	.....	268.2	269.3	269.4	269.4	271.3	271.7
14	.....	268.1	269.2	269.4	269.4	271.1	271.6
15	.....	268.1	269.2	269.4	269.4	270.9	271.6
16	.....	268.0	269.2	269.5	269.4	271.2	271.5
17	.....	267.8	269.1	269.4	269.4	271.4	271.4
18	.....	267.8	269.1	269.4	269.4	270.7	271.4
19	.....	267.8	269.1	269.4	269.4	271.4	271.4
20	.....	267.9	269.1	269.4	269.4	271.6	271.4
21	.....	268.0	269.1	269.4	269.4	272.6	272.2
22	.....	270.0	269.1	269.4	269.4	273.1	276.2
23	.....	269.9	269.1	269.4	269.4	271.6	275.0
24	.....	269.5	269.1	269.4	269.4	271.8	273.8
25	268.2	272.0	270.4	269.4	269.4	271.7	275.0
26	268.5	273.7	270.2	269.4	269.4	273.2	273.3
27	268.1	273.1	270.2	269.4	269.4	274.8	272.3
28	267.9	272.2	269.5	269.4	269.4	274.3	...
29	267.9	270.6	269.3	269.4	.....	272.6	...
30	267.9	270.1	269.2	269.4	.....	272.2	...
31	267.9	.....	269.2	269.4	.....	270.9	...

Mean daily elevation of water surface of Mohawk River at Yosts, N. Y. Gage No. 14.

Day.	1900.			1901.			
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.
1	.....	276.4	279.9	278.2	277.5	277.4	280.5
2	.....	276.4	279.0	277.8	277.4	277.4	279.5
3	.....	276.3	278.5	277.5	277.4	277.5	281.0
4	.....	276.1	278.3	277.2	277.4	277.5	283.0
5	.....	275.9	282.0	277.2	277.4	277.6	283.7
6	.....	275.9	280.8	277.3	277.4	277.9	283.1
7	.....	276.0	280.5	277.4	277.6	277.7	284.2
8	.....	276.4	280.3	277.5	277.8	277.4	285.0
9	.....	279.4	280.1	277.7	277.8	277.6	284.7
10	.....	278.7	278.6	278.9	277.7	278.4	283.6
11	.....	277.7	277.8	279.1	277.6	279.0	282.7
12	.....	277.0	278.9	279.1	277.5	280.0	282.0
13	.....	276.8	278.8	279.0	277.7	280.0	281.7
14	.....	276.6	279.1	278.7	277.7	279.7	281.9
15	.....	276.5	278.4	278.6	277.7	279.5	282.3
16	.....	276.3	278.1	278.5	277.6	280.1	282.3
17	.....	276.2	278.1	278.5	277.5	280.2	281.8
18	.....	276.1	278.1	278.9	277.5	279.8	282.0
19	.....	276.4	278.0	278.6	277.5	281.7	282.0
20	.....	278.0	278.4	278.1	277.6	281.4	281.7
21	.....	280.2	278.4	277.8	277.6	283.0	281.7
22	.....	280.0	278.3	278.1	277.5	285.8	286.0
23	.....	279.5	278.1	278.6	277.6	285.1	...
24	.....	278.7	278.2	278.6	277.5	285.4	285.5
25	.....	278.1	280.9	278.3	277.4	285.4	285.0
26	.....	284.3	281.1	278.1	277.4	287.2	282.8
27	.....	286.6	280.4	277.9	277.5	289.2	281.5
28	.....	286.4	279.1	277.7	277.5	288.2	...
29	276.7	282.9	278.8	277.6	...	284.9	...
30	276.5	281.3	278.3	277.5	...	282.7	...
31	276.3	.....	278.1	277.5	...	281.4	...

Mean daily elevation of water surface of Mohawk River at Canajoharie, N. Y. Gage No. 15.

Day.	1900.			1901.			
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.
1	.....	286.2	288.1	287.8	286.2	285.9	289.4
2	.....	285.8	288.6	287.0	286.1	286.0	289.7
3	.....	285.7	287.0	286.2	286.1	286.0	290.2
4	.....	285.7	287.3	286.4	286.1	286.0	291.5
5	.....	285.4	289.3	286.1	286.0	286.2	292.1
6	.....	285.4	289.2	287.1	286.0	286.3	291.5
7	.....	284.8	289.5	286.1	286.0	286.2	292.5
8	.....	284.8	289.0	786.5	285.9	286.1	293.1
9	.....	289.4	288.7	287.1	285.9	286.2	293.1
10	.....	287.8	288.1	228.1	285.9	287.0	292.1
11	.....	287.7	288.5	288.5	285.9	287.7	291.1
12	.....	286.3	288.8	287.8	285.9	288.4	290.4
13	.....	286.2	291.0	288.1	285.9	288.4	290.4
14	.....	286.3	290.4	287.4	285.9	288.4	290.8
15	.....	286.2	288.7	287.4	285.9	288.2	291.3
16	.....	285.6	289.3	287.0	285.9	288.5	291.1
17	.....	285.5	289.2	286.4	286.0	290.5	290.5
18	.....	285.7	287.7	286.2	286.1	288.4	291.0
19	.....	286.1	287.2	286.2	286.2	289.2	290.9
20	.....	286.9	288.2	286.4	286.2	289.0	290.4
21	.....	288.2	288.0	286.5	286.2	291.7	290.4
22	.....	287.8	287.7	287.2	286.2	293.5	293.5
23	.....	288.4	287.9	287.1	286.2	293.0	294.9
24	.....	287.9	288.0	286.8	286.1	292.8	293.6
25	286.9	287.4	290.4	286.9	265.9	292.9	292.9
26	286.2	293.3	291.1	286.5	286.0	292.9	291.5
27	285.9	294.7	290.0	286.5	286.1	296.1	290.5
28	285.9	294.5	289.1	286.5	285.9	296.0	289.7
29	285.9	291.6	288.2	286.2	.....	293.0	288.7
30	285.8	289.7	287.9	286.2	.....	291.4	287.9
31	286.3	.....	287.8	286.2	.....	290.3	.....

Mean daily elevation of water surface of Mohawk River at St. Johnsville. Gage No. 16.

Day.	1900.			1901.			
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.
1	.....	298.9	301.8	300.2	299.9	.....	302.1
2	.....	298.9	301.1	299.9	300.0	.....	301.6
3	.....	298.7	300.6	299.6	299.9	299.6	302.6
4	.....	298.5	300.7	299.5	299.9	299.6	304.0
5	.....	298.4	303.2	299.6	300.0	299.6	304.3
6	.....	298.4	302.4	299.8	300.2	299.6	304.6
7	.....	298.5	302.4	299.6	300.3	299.6	305.0
8	.....	299.9	302.2	299.8	300.3	299.6	305.6
9	.....	302.4	301.5	300.8	300.1	299.7	305.0
10	.....	301.6	300.6	301.1	300.0	300.0	304.6
11	.....	300.1	300.0	301.2	300.0	300.4	303.5
12	.....	299.4	300.0	301.0	299.9	300.9	303.2
13	.....	299.2	300.2	300.8	299.9	301.1	303.2
14	.....	299.2	299.7	300.6	299.9	301.0	.....
15	.....	299.2	301.6	300.4	299.9	300.9	.....
16	.....	298.8	301.3	300.4	299.9	301.2	.....
17	.....	298.7	301.0	300.5	299.8	301.2	.....
18	.....	298.6	300.6	300.8	299.9	300.9	.....
19	.....	299.8	300.8	300.5	299.9	302.3	.....
20	.....	301.9	301.0	300.3	300.0	302.0	.....
21	.....	203.4	301.0	300.2	299.9	304.0	.....
22	.....	302.9	300.4	300.8	299.9	305.6	.....
23	.....	302.2	300.2	300.8	299.7	307.0	.....
24	.....	301.0	301.1	300.6	.....	308.2	.....
25	.....	301.1	303.0	300.4	.....	308.0	.....
26	.....	307.6	303.0	300.3	.....	307.9	.....
27	.....	308.2	302.2	300.2	.....	310.1	.....
28	299.1	307.6	391.1	300.1	.....	309.1	.....
29	299.1	303.8	300.6	300.1	.....	305.8	.....
30	298.9	302.6	300.5	300.1	.....	304.0	.....
31	298.7	.....	300.2	300.0	.....	302.9	.....

Mean daily elevation of water surface of Mohawk River at Rocky Rift dam. Gage No. 17.

Day.	1900.			1901.			
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.
1	.....	316.6	319.3	.....	316.7	316.6	319.1
2	.....	316.7	318.6	.....	316.6	316.6	319.0
3	.....	316.5	318.2	.....	316.6	316.6	319.5
4	.....	316.4	318.1	.....	316.6	316.6	321.1
5	.....	316.3	319.9	.....	316.7	316.6	321.3
6	.....	316.3	320.0	.....	316.8	316.7	321.4
7	.....	316.4	320.7	.....	316.9	316.8	321.7
8	.....	318.2	320.1	317.3	316.9	317.1	322.4
9	.....	319.7	319.3	317.4	317.0	317.1	322.8
10	.....	318.6	318.5	318.1	316.9	317.3	322.2
11	.....	317.7	317.9	318.3	316.8	317.6	320.9
12	.....	317.1	317.8	318.1	316.8	317.9	320.4
13	.....	317.1	317.6	318.0	316.9	317.8	320.3
14	.....	316.9	317.5	317.7	317.2	317.7	320.3
15	.....	316.9	317.3	317.5	317.1	317.9	320.3
16	.....	316.8	317.2	317.4	316.8	317.9	320.2
17	.....	316.6	317.2	317.5	316.7	318.0	320.3
18	.....	316.6	317.1	316.9	316.7	318.1	320.3
19	.....	317.0	317.3	317.3	316.7	319.2	320.4
20	.....	318.9	317.6	317.3	316.7	319.8	320.1
21	.....	320.2	317.6	316.8	316.6	321.4	320.2
22	.....	319.2	317.5	317.0	316.5	321.7	322.1
23	.....	319.2	317.5	317.5	316.5	322.1	324.3
24	.....	318.5	318.5	317.2	316.5	321.6	323.7
25	.....	319.4	319.6	316.8	316.5	321.5	322.2
26	.....	321.0	319.7	317.3	316.5	322.7	320.8
27	.....	325.3	319.2	317.0	316.5	324.2	320.1
28	316.7	324.7	318.6	316.8	316.5	323.7	319.6
29	316.9	322.1	317.8	316.7	.....	322.4	319.4
30	316.7	320.0	317.5	316.7	.....	321.2	319.3
31	316.8	.....	317.5	316.7	.....	320.1	.....

Mean daily elevation of water surface of Mohawk River above crest of Rocky Rift dam. Gage No. 18.

Day.	1900.			1901.			
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.
1	.....	322.1	322.9	.....	321.8	320.2	321.8
2	.....	322.1	322.6	.....	321.8	320.2	321.9
3	.....	322.0	322.4	.....	321.8	320.1	322.5
4	.....	321.9	322.4	.....	321.8	320.0	323.5
5	.....	321.8	323.1	.....	321.8	320.0	323.4
6	.....	321.8	323.2	.....	321.8	320.0	322.8
7	.....	321.9	323.2	.....	321.8	320.1	323.0
8	.....	322.8	323.1	321.9	321.8	320.3	323.1
9	.....	323.3	322.6	322.2	321.8	320.3	323.2
10	.....	322.7	322.2	322.3	321.7	320.4	322.9
11	.....	322.3	322.1	322.4	321.7	320.8	322.7
12	.....	321.9	322.2	322.4	321.6	320.8	322.8
13	.....	321.9	322.1	322.3	321.6	320.8	322.3
14	.....	321.9	322.0	322.2	321.8	320.8	322.8
15	.....	321.9	322.0	322.0	321.8	320.8	322.6
16	.....	321.8	321.9	322.1	321.7	320.9	322.4
17	.....	321.7	322.0	322.2	321.6	320.8	322.5
18	.....	321.7	321.9	322.0	321.6	321.1	322.5
19	.....	321.9	322.0	321.8	321.6	321.8	322.5
20	.....	322.8	322.1	321.8	321.5	321.8	322.6
21	.....	323.4	322.2	322.0	321.1	323.1	322.2
22	.....	323.1	322.0	322.2	320.6	323.1	323.5
23	.....	322.8	322.1	322.3	320.3	323.0	324.2
24	.....	322.5	322.5	322.0	320.3	322.9	324.4
25	.....	322.6	323.0	322.0	320.3	322.9	323.3
26	.....	325.5	323.1	321.9	320.3	324.3	322.6
27	.....	326.5	322.9	321.8	320.3	325.3	322.4
28	322.1	326.2	322.5	321.8	320.3	325.0	322.0
29	322.2	324.5	322.2	321.8	.....	323.5	321.8
30	322.1	323.3	322.1	322.0	.....	322.8	321.8
31	322.0	.....	322.1	322.1	.....	322.0	.....

Mean daily elevation of water surface of Mohawk River above Little Falls dam. Gage No. 23.

Day.	1900.			1901.			
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.
1	.....	363.8	364.9	364.2	363.8	363.8	365.0
2	.....	363.8	364.6	364.2	363.7	363.9	364.8
3	.....	363.7	364.4	364.1	363.8	364.0	365.5
4	.....	363.7	364.5	364.0	363.8	364.0	365.8
5	.....	363.8	365.5	363.9	363.8	363.9	365.8
6	.....	363.6	365.2	363.9	363.7	363.8	365.7
7	.....	363.7	365.4	363.9	363.8	363.8	366.0
8	.....	364.6	365.2	363.9	363.8	363.8	366.3
9	.....	365.3	364.8	364.3	363.9	363.9	366.4
10	.....	364.7	364.2	364.4	363.9	364.2	366.1
11	.....	364.3	363.9	364.4	363.9	364.2	365.7
12	.....	364.0	364.2	364.4	363.9	364.3	365.5
13	.....	363.9	364.1	364.3	363.8	364.4	365.5
14	.....	363.9	364.0	364.1	363.8	364.4	365.6
15	.....	363.9	364.0	364.2	363.8	364.4	365.4
16	.....	363.8	364.1	364.2	364.0	364.4	365.6
17	.....	363.7	364.0	364.2	363.9	364.4	365.6
18	.....	362.8	364.0	364.3	363.9	364.3	365.7
19	.....	364.0	364.0	364.1	363.0	364.7	365.6
20	.....	365.0	364.1	364.0	363.9	364.7	365.4
21	.....	365.6	364.2	363.9	363.9	365.3	365.3
22	.....	365.5	364.2	364.1	363.8	365.8	366.6
23	.....	365.0	364.3	364.1	363.8	366.1	366.6
24	.....	364.6	364.7	364.1	363.9	366.0	366.4
25	.....	364.9	365.0	364.1	363.9	366.1	366.2
26	.....	367.5	365.2	364.0	363.9	367.4	365.9
27	.....	368.1	365.1	363.8	363.8	369.1	365.5
28	363.9	367.5	364.5	363.9	363.8	368.6	.....
29	364.0	366.0	364.4	363.8	.....	367.2	.....
30	363.8	365.4	364.2	363.9	.....	366.1	.....
31	363.8	.....	364.3	363.8	.....	365.5	.....

Mean daily elevation of water surface of Mohawk River at Herkimer, N. Y. Gage No. 24.

Day.	1900.			1901.			
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.
1	.....	375.5	380.1	.....	377.6	382.6	378.1
2	.....	375.2	377.1	.....	378.3	381.6	378.6
3	.....	374.7	377.4	.....	378.2	381.1	380.1
4	.....	.....	378.0	.....	377.6	380.6	380.1
5	.....	.....	378.6	.....	377.4	379.6	380.6
6	.....	375.6	379.2	.....	377.1	379.6	380.8
7	.....	376.2	379.2	.....	377.6	378.6	381.2
8	.....	377.4	377.9	377.6	378.3	378.6	381.5
9	.....	378.3	377.3	377.6	378.6	383.6	381.1
10	.....	377.3	377.0	377.6	378.3	377.3	380.6
11	.....	376.5	377.0	378.1	388.3	378.4	380.6
12	.....	376.0	377.1	378.6	378.1	378.5	380.1
13	.....	375.4	377.6	377.9	377.9	378.5	379.6
14	.....	375.3	377.6	377.8	377.2	377.6	379.1
15	.....	375.1	377.8	377.6	376.9	377.1	378.6
16	.....	375.5	377.6	377.8	376.6	377.6	378.6
17	.....	375.5	377.8	378.4	377.0	378.1	378.6
18	.....	374.5	377.8	378.2	377.0	378.6	378.4
19	.....	376.0	378.9	378.4	377.1	379.6	378.4
20	.....	376.7	379.3	378.4	377.4	381.4	378 4
21	.....	377.3	379.2	378.8	377.3	382.6	.....
22	.....	378.5	379.1	378.8	377.2	380.9	.....
23	.....	378.5	378.8	377.6	376.8	380.2	.....
24	.....	378.6	378.6	376.8	376.8	380.5	.....
25	.....	379.3	379.4	376.6	376.6	381.4	.....
26	.....	382.6	379.1	377.2	376.6	383.1	.....
27	.....	383.9	378.9	377.2	383.6	384.7	.....
28	375.3	383.2	378.6	377.4	382.6	384.2	.....
29	375.2	382.0	378.0	377.9	.....	382.9	.....
30	374.8	380.6	.....	378.4	.....	382.3	.....
31	374.8	.....	.....	378.1	.....	378.4	.....

During the severe winter months the river was frozen over throughout the greater portion of its length; the greatest depth of ice at the gaging stations varied from 2 to 3 feet. When the river was frozen,

holes were chopped through the ice around the gages. At such times the readings show the elevation of the water surface as it rose in these openings.

Readings were not taken simultaneously at the different stations. In reducing the records, the means of the two daily readings at each station have been used to determine the fall and surface slope from station to station. The accompanying tables show the resulting mean elevation of water surface at the principal stations:

Mean elevation of water surface at Mohawk River slope gages.

Gage No.	Location.	Elevation of gage zero.	Difference of elevation of gage zeros.
		Feet.	*Feet.*
1	Above Cohoes Company's dam	150.95	----------
2	Below West Troy Company's dam, Dunsbach Ferry	164.30	13.35
3	Above West Troy Company's dam, Dunsbach Ferry	172.23	7.93
4	Vickers Ferry bridge	174.09	1.86
5	Below Rexford Flats dam	204.38	30.29
6	Above Rexford Flats dam	208.35	3.97
8	Freeman's bridge, Schenectady	203.76	4.59
9	Hoffmans Ferry	232.56	28.80
10	Amsterdam	248.45	15.89
13	Fort Hunter	267.56	19.11
14	Yosts	274.69	7.13
15	Canajoharie	284.68	9.99
16	St. Johnsville	297.37	12.69
17	Below Rocky Rift dam	315.40	18.03
18	Above Rocky Rift dam	319.78	4.38
19	Below Little Falls Paper Company's mill	321.00	1.22
20	Above Gilbert's dam, Little Falls, N. Y	333.81	12.81
23	Above New York State dam, Little Falls, N. Y	362.29	28.48

Gage No. 1.—Above Cohoes Company's dam. Record from October 28, 1900, to April 27, 1901, inclusive. Readings in feet and tenths were taken between 6 and 7 a. m. and again between 6 and 7 p. m. William Butler, observer. Gage was attached vertically to crib work back of masonry ice breaker 150 feet upstream from right-hand end of the Cohoes Company's dam.

Gage No. 2.—Below West Troy Company's dam. Readings in feet and decimals, taken at 7 a. m. and between 4.30 and 5.30 p. m. Frederick H. Burgess, gage reader.

March 23, 1901, an ice gorge 2 miles below this dam backed water to at least 17 feet on gage No. 2 and carried away part of gage. Ice was left in piles from 10 to 12 feet high along the banks.

Gage No. 3.—Above West Troy Company's dam. Readings taken from 5 to 5.30 p. m. by Frederick Burgess. Readings to 5 feet were taken from vertical gage attached to bulkhead above dam. Readings of 5 feet or over were taken from gage attached to face of forebay timber adjoining pump house. Gage was divided decimally and is situated about 50 feet upstream from lower section of dam, right-hand end.

Gage No. 4.—Vickers Ferry bridge, L. S. Clute, observer. Readings in feet and decimals, taken at 6 a. m. and 5 to 6 p. m. December 7, 1900, river became blocked by ice, submerging the gage. March 22, 1901, 3.30 a. m., an ice gorge broke away. Maximum gage reading, 14 feet.

Gage No. 5.—Below Rexford Flats dam, H. R. Betts, observer. Record from

October 21, 1900, to May 4, 1901, inclusive. Readings in feet and tenths. Gage was attached to lower end face of the right-hand abutment of dam. Gage carried away by high water March 27, 1901, and measurements from that date were made in feet and inches from corner of bulkhead down to water surface.

Gage No. 6.—Fifty feet above Rexford Flats dam, H. R. Betts, observer. Gage divided decimally.

Gage No. 9.—Mohawk River at Hoffmans Ferry, L. D. Phillips, observer. Readings taken at 9 a. m. in feet and decimals, from October 24, 1900, to April 30, 1901. Gage board in three sections attached vertically to trees on left bank 50 feet upstream from ferry cable.

Gage No. 10.—Amsterdam, on Mohawk River, E. Simkins, observer. Readings taken in feet and decimals at 7.30 a. m. and 4.30 p. m., from October 24, 1900, to April 27, 1901, inclusive. Owing to breaking up of ice the water rose on March 22, 1901, and broke gage at 7.6 foot elevation. All readings after that date above 7.6 were estimated from the noted position of points on the bridge pier. Gage was attached vertically to east end of north pier of highway bridge.

Gage No. 13.—Mohawk River at Fort Hunter. A vertical gage board, divided decimally, was attached to downstream face of north abutment of suspension bridge. John Brown, observer. Readings usually taken at 8 a. m. and 5 p. m., from October 25, 1900, to April 27, 1901, inclusive. Gage board was attached vertically to tree on left bank of stream 100 feet below railroad station.

Gage No. 14.—Mohawk River at Yosts, Fred Birch, gage reader. Gage board attached vertically to tree on left-hand bank of stream 500 feet below railroad station. Readings taken in feet and decimals at 8 a. m. and 4 p. m. each day, from October 29, 1900, to April 27, 1901, inclusive. April 23, 1901, gage submerged by high water; reading about 13.6 feet.

Gage No. 15.—Canajoharie or Palatine bridge, William Hout, observer. Readings in feet and decimals taken at 7 a. m. and 5 p. m., from October 25, 1900, to April 30, 1901. Gage board attached vertically to second pier from right bank, Palatine bridge. December 13, 1900, river was blocked with ice. River surface became frozen December 15, 1900. March 26, 1901, ice broke up and water rose above top of gage.

Gage No. 16.—On Mohawk River at St. Johnsville, W. B. Bucklin, observer. Readings taken in feet and decimals at 7.30 a. m. and 4.30 p. m., October 28, 1900, to April 13, 1901, inclusive, except February 24 to March 2, 1901. Gage board was attached vertically to face of old bridge abutment on left-hand side of stream, 50 feet above present highway bridge.

Gage No. 17.—Below Rocky Rift dam, 5 miles below Little Falls, J. H. Nickerson, observer. A vertical gage board divided decimally was attached to a basswood tree, 100 feet above the mouth of Crum Creek and about 280 feet below Rocky Rift dam. Readings taken from 7.30 to 9.20 a. m. and usually from 4 to 5 p. m., from October 28, 1900, to April 30, 1901, inclusive.

Gage No. 18.—Gage board was attached vertically to left-hand abutment of dam, 18 feet upstream from crest, divided decimally. Readings were taken at the same time as those of gage No. 17.

Gage No. 19.—In tailrace of Little Falls Paper Company's mill, 800 feet downstream from Gilbert's dam. Gage divided in feet and inches. Readings taken once each day by William Hoffman.

Gage No. 23.—Above New York State dam at Little Falls, Charles B. Edic, observer. Readings in feet and decimals, usually at 8 a. m. and 5 p. m.

Gage No. 24.—Mohawk River at Herkimer. Gage attached to face of north abutment of Washington street highway bridge.

In order to compute the results the river has been divided into thirteen slope sections, each covering the portion of the river between two successive gages. The line of gages extended from the Washington

street bridge at Herkimer to the dam of the Cohoes Water Power Company. Throughout their entire length the slope sections are paralleled by Erie Canal. The records were not maintained during the season of canal navigation. However, the canal intercepts some run-off which is usually carried in the canal to the nearest aqueduct or waste weir, and there turned into the river. There are ten waste weirs in this portion of the canal.

At the entrance of every important tributary a gravel bar has been formed extending into or across the channel of the Mohawk, and forming a sort of submerged dam over which a rift appears in low water. Many low-lying islands obstruct the stream channel. These for the most part are submerged during high water.

Elements of Mohawk River slope sections.

No.	From—	To—	Length.	Drainage area (square miles).			
				Head.	Foot.	Difference.	Mean.
			Feet.				
1	Herkimer	Little Falls State dam	39,789	701	1,296	595	998½
2	Gilbert's dam	Rocky Rift dam	21,864	1,306	1,337	31	1,321½
3	Rocky Rift dam	St. Johnsville	30,996	1,337	1,687	350	1,362
4	St. Johnsville	Canajoharie	46,964	1,687	1,862	175	1,774½
5	Canajoharie	Yosts	35,223	1,862	2,003	141	1,932½
6	Yosts	Fort Hunter	54,140	2,003	3,094	1,091	2,548½
7	Fort Hunter	Amsterdam	28,048	3,094	3,196	102	3,145
8	Amsterdam	Hoffmans Ferry	35,875	3,196	3,248	52	3,222
9	Hoffmans Ferry	Schenectady	60,658	3,248	3,311	63	3,279½
10	Schenectady	Rexford Flats	14,350	3,311	3,385	74	3,348
11	Rexford Flats	Vischers Ferry	27,410	3,385	3,408	23	3,396½
12	Vickers Ferry	West Troy Co.'s dam	22,830	3,408	3,440	32	3,424
13	West Troy Co.'s dam	Cohoes Co.'s dam	28,048	3,440	3,465	25	3,452½

Mean elevation of stream bed, Mohawk River slope sections.

No.	From—	To—	Number of cross sections.	Average elevation of stream bed.	Average width of stream bed.
1	Herkimer	Little Falls State dam	97	362.14	303
2	J. J. Gilbert's dam	Rocky Rift dam			
3	Rocky Rift dam	St. Johnsville	85	304.44	318
4	St. Johnsville	Canajoharie	60	288.28	380
5	Canajoharie	Yosts	56	273.76	295
6	Yosts	Fort Hunter	85	268.62	448
7	Fort Hunter	Amsterdam	37	256.99	675
8	Amsterdam	Hoffmans Ferry	50	235.50	595
9	Hoffmans Ferry	Schenectady	83	211.82	470
10	Schenectady	Rexford Flats	22	200.80	655
11	Rexford Flats	Vischer Ferry	43	185.10	535
12	Vickers Ferry	Dunsbach Ferry	37	166.73	458
13	Dunsbach Ferry	Cohoes Co.'s dam	44	152.33	302

Slope section No. 1 extends from Herkimer to Little Falls State dam, a distance of 7.5 miles. The stream is tortuous, and contains a number of large islands. The channel is in earth throughout and the stream bed is of earth, gravel, and cobble. It is bordered by extensive flood plains, affording surface storage during freshets. Backwater from Little Falls State dam affects the current throughout much of the length of the section.

One-half mile below the Herkimer gage West Canada Creek enters the Mohawk, contributing the run-off from a drainage area of 569 square miles. The only other tributary of consequence is Beaver Brook, entering from the north, in the middle of the section.

Slope section No. 2 extends from the foot of the rapids below the lower or Gilbert dam, in Little Falls, to Rocky Rift or Five-Mile Feeder dam of New York State canals. The section is 4.1 miles in length. With the exception of the first

mile, which is rocky, the stream channel is fairly straight and uniform. There is very little fall in this section, owing to backwater from Rocky Rift dam. The stream banks are overflowed in high water. The entering tributaries are small and quite uniformly distributed through the length of the slope section. The largest is Noudaga Creek. Its watershed lies south of the river, near the head of the slope section.

Slope section No. 3 extends from the foot of the rapids below Rocky Rift dam to a point about 50 feet above St. Johnsville highway bridge. East Canada Creek enters the section from the north halfway between the two terminal gaging stations. The drainage area of East Canada Creek is 283 square miles. Other tributaries entering from the north are Crum Creek, Klock Creek, and Zimmerman Creek. Tributaries from the south or canal side are unimportant.

The stream channel is fairly straight, containing occasional islands. The length of the section is 5.8 miles.

Slope section No. 4 lies between the St. Johnsville and Canajoharie highway bridges; its length is 8.9 miles. Canajoharie Creek, draining an area of 69 square miles, enters on the south, 500 feet below the head of the section. Otsquaga Creek, having a drainage area of 54 square miles, enters from the south at Fort Plain, near the middle of the section. On the north side of the stream the only important tributary is Caroga Creek. This stream has a drainage area of 89 square miles. It flows into Mohawk River 3 miles below St. Johnsville. The river flows in a fairly uniform channel, with occasional islands, and is bordered by a narrow flood plain. A high-water mark near Palatine bridge, at the head of the section, shows the water to have risen to elevation 304.2, as the result of an ice gorge in the spring of 1893.

Slope section No. 5, from Canajoharie bridge to a point 500 feet downstream from Yosts station, includes a portion of the river channel 6.7 miles in length. The most important tributary is Flat Creek, draining an area of 42 square miles, which enters the Mohawk from the south at Sprakers, near the middle of the slope section. The upper portion of the section contains a number of islands.

Below Sprakers the channel is of nearly uniform width, the bends are of large radius, and the regimen, as a slope section, good.

Slope section No. 6, extending from the gage near Yosts to Fort Hunter suspension bridge, comprises a stretch of the Mohawk without islands or abrupt bends, and of nearly uniform width. It receives a number of tributaries.

Tributaries entering Mohawk River between Yosts and Fort Hunter.

Name of tributary.	Distance from head of slope section.	Drainage area.	Enters which side of river.
	Miles.	*Sq. miles.*	
Yatesville Creek	0.0		South.
Briggs River	1.0		North.
Allston Creek	2.0		South.
Cayadutta Creek	5.0	62	North.
Danoscara Creek	8.5		Do.
Aurie Creek	8.5	42	South.
Schoharie Creek	9.7	947	Do.

The total length of the section is 10.2 square miles. Schoharie Creek enters one-half mile above the lower end of the slope section. Its drainage, therefore, more properly belongs to the next lower slope section. Its relatively large run-off during freshets produces backwater, reducing the effective slope of the section above. The drainage area at the foot of the section, not including Schoharie Creek, is 2,147 square miles, and the mean for the section is 2,075 square miles.

Yatesville Creek enters the Mohawk just above the upstream end of the section

under consideration: its drainage area has been included in the present section, to which it more properly belongs, rather than in that of the section next above.

Slope section No. 7 includes Mohawk River from Fort Hunter to Amsterdam, a distance of 5.3 miles. The stream channel is broad and for the most part divided into two parallel courses by a line of narrow islands extending through its center. The largest tributary is South Chuctenunda Creek, which enters 1,000 feet above the downstream end of the section. Kyaderoseras Creek enters at Aiken nearly mid-length of the section.

Slope section No. 8 extends from Amsterdam to a point 50 feet upstream from Hoffmans Ferry cable. It includes a length of 6.8 miles, through which the river flows in a broad and nearly straight channel, interspersed with islands. Numerous small tributaries enter from both the north and south slopes, the most important being North Chuctenunda Creek, at the head of the section.

Slope section No. 9 extends from Hoffmans Ferry to Freeman's bridge, 1 mile below Schenectady, a total distance of 11.3 miles. In the vicinity of Schenectady the stream has several abandoned channels, of which Binne Kill is the largest. Through these the water flows during freshets. During low water they become stagnant lagoons, inclosing large islands. Verf Kill, Poentic Kill, and Plotter Kill and other small tributaries enter this section.

A high-water mark at Glenville bridge, Schenectady, shows an elevation of the water surface of 220.9 feet.

Slope section No. 10 covers a length of 2.7 miles from Freeman's bridge to the State feeder dam at Rexford Flats. The water level is controlled by the dam at the foot of the section, which forms a long, broad pond. Alplaus Kill is the only important tributary. This has a drainage area of 52 square miles, and enters from the north about 1 mile above the Rexford Flats dam.

At Delaware and Hudson Railroad bridge, near the head of the section, the highest recorded water mark is elevation 222.9.

Slope section No. 11, reaching from below Rexford Flats dam to Vickers Ferry highway bridge, includes a length of the stream of 5.2 miles. The river channel is straight, of varying width, and mostly free from islands. The fall is comparatively rapid. Below Rexford Flats the Erie Canal crosses Mohawk River, following the left bank from the aqueduct to Crescent, where it recrosses to the right bank. The tributaries are small. Stony Kill, the largest, enters from the north, near the foot of the section.

Slope section No. 12, 4.3 miles in length, extends from Vickers Ferry bridge to West Troy Company's dam, near Dunsbach Ferry. Much of the section is included in flowage from the dam at its foot. In the upper reaches of this section the river broadens out and infolds a number of islands. At Niskayuna the recorded flood elevation is 187.9. At Forts Ferry the water is stated to have reached a height of 185.5 feet.

Slope section No. 13, extending from below Dunsbach Ferry dam to Cohoes Company's dam, includes 5.3 miles of the stream. The surface level is affected by backwater from Cohoes Company's dam.

Lower Mohawk River high-water marks. [a]

Location.	Elevation.	Date.
	Feet.	
Dunsbach Ferry bridge	187.6	Spring 1868.
Do	181.0	Ice gorge, spring 1893.
Crescent aqueduct	179.0	Ice, spring 1868.
Do	174.3	Ordinary spring freshet.
Cohoes Company's dam	165.2	Ice freshet, spring 1868.
Do	161.9	March 16, 1889.

[a] From United States Deep Waterways Maps.

Fall of Mohawk River from gage No. 2, below West Troy Company's dam, to gage No. 1, above Cohoes Company's dam.

Day.	1900.			1901.			
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.
1	.....	11.10	11.75	11.20	11.15	11.35	9.90
2	.....	11.05	11.25	11.30	11.10	10.90	11.05
3	.....	10.85	11.45	11.15	10.65	10.75	11.90
4	.....	10.70	11.40	11.05	11.20	11.10	8.30
5	.....	11.05	12.18	11.05	11.32	10.95	9.45
6	.....	10.95	12.10	10.85	11.35	10.90	9.80
7	.....	11.00	11.85	11.05	11.34	10.95	9.20
8	.....	11.15	11.90	10.95	11.82	10.80	7.10
9	.....	11.30	11.55	10.80	11.46	10.75	8.65
10	.....	11.65	11.20	11.05	10.55	10.70	9.75
11	.....	10.95	11.60	11.30	11.60	10.85	9.45
12	.....	10.95	11.45	11.20	12.08	11.30	8.65
13	.....	11.05	11.60	11.15	12.03	11.50	8.60
14	.....	11.00	11.30	11.10	11.99	11.25	8.65
15	.....	11.10	11.10	11.25	11.95	11.25	8.70
16	.....	11.07	10.95	11.20	11.93	11.25	8.75
17	.....	10.90	11.15	11.20	10.60	11.25	8.75
18	.....	10.70	11.15	11.40	11.53	11.35	8.85
19	.....	11.00	11.20	11.50	11.97	11.70	8.85
20	.....	10.90	11.25	11.25	11.98	11.85	8.90
21	.....	11.40	11.15	11.05	12.09	9.95	8.15
22	.....	11.60	10.95	10.85	11.97	.....	.....
23	11.80	11.45	11.05	11.00	11.47	.....	.....
24	11.30	11.40	10.85	11.20	10.65	.....	7.30
25	11.85	11.20	11.00	11.09	11.15	.....	6.95
26	11.12	11.55	11.90	11.05	11.30	.....	7.05
27	10.95	13.25	11.65	10.90	11.40	.....	10.55
28	10.85	12.90	11.60	11.10	11.35	.....	.....
29	11.10	12.30	11.35	11.10	.....	9.10	.....
30	10.95	11.85	11.10	10.80	.....	8.70	.....
31	11.00	.....	11.05	10.90	.....	9.25	.....

Fall of Mohawk River from Vickers Ferry, gage No. 4 to West Troy Company's dam, gage No. 3.

Day.	1900.			1901.			
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.
1	.....	−0.04	1.96	2.31	1.71	1.41	0.81
2	.....	− .04	.66	2.56	1.71	1.31	.71
3	.....	− .04	.46	3.01	1.31	1.16	.76
4	.....	− .04	.26	2.76	1.41	1.26	1.66
5	.....	− .19	1.11	2.66	1.36	1.16	2.01
6	.....	− .14	1.21	2.36	1.46	1.11	2.06
7	.....	− .19	.86	2.36	1.46	1.26	2.41
8	.....	− .24	.66	2.41	1.46	1.31	3.46
9	.....	.41	.56	2.56	1.46	1.21	2.46
10	.....	.36	1.06	2.46	1.61	1.31	2.11
11	.....	.36	2.16	2.66	1.31	1.91	1.66
12	.....	.16	2.06	2.56	1.61	1.86	2.91
13	.....	.06	2.51	2.46	1.46	1.86	1.31
14	.....	.16	2.61	2.46	1.51	1.56	1.41
15	.....	.16	2.51	2.51	1.46	1.71	1.36
16	.....	.06	2.91	2.46	1.46	1.76	1.36
17	.....	.01	2.61	2.56	1.46	1.56	1.26
18	.....	.01	2.66	2.36	1.46	1.71	1.21
19	.....	− .04	2.56	2.01	1.36	1.86	1.31
20	.....	.11	2.56	2.21	1.21	2.16	1.26
21	.....	.36	2.71	2.16	1.41	2.01	1.56
22	.....	.46	2.66	2.16	1.46	2.96	5.51
23	−0.04	.46	2.56	2.16	1.36	1.91	3.61
24	− .04	.46	2.56	2.11	1.26	1.81	3.01
25	− .04	.36	2.81	2.16	1.26	1.81	3.06
26	.11	.76	3.01	2.06	1.31	2.76	3.26
27	.21	2.31	2.86	2.21	1.41	2.71	1.76
28	.01	2.26	2.76	1.76	1.01	3.36	1.26
29	− .04	1.76	2.41	1.76	.....	2.31	.91
30	− .09	1.16	2.61	1.71	.....	1.41	.76
31	.01	.....	2.26	1.71	.....	1.06	.....

Fall of Mohawk River from Rexford Flats, gage No. 5, to Vickers Ferry, gage No. 7.

Day.	1900.			1901.			
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.
1	.....	29.44	28.34	27.39	28.14	28.74	30.02
2	.....	29.59	28.79	27.09	28.24	28.79	30.69
3	.....	29.49	29.14	26.79	28.44	28.89	30.52
4	.....	29.49	29.09	27.04	28.39	28.79	27.35
5	.....	29.64	27.99	27.29	28.39	28.84	26.82
6	.....	29.69	27.74	27.39	28.39	28.69	26.84
7	.....	29.79	28.29	27.29	28.44	28.59	30.10
8	.....	29.86	28.39	27.11	28.59	28.59	26.99
9	.....	30.04	28.59	26.86	28.59	28.69	30.28
10	.....	29.39	.....	27.19	28.44	28.69	31.88
11	.....	29.49	.....	26.94	28.64	28.19	33.46
12	.....	29.64	.....	26.89	28.39	27.99	32.89
13	.....	29.74	.....	27.04	28.54	27.99	34.63
14	.....	29.69	.....	26.99	28.59	28.04	27.50
15	.....	29.69	.....	27.09	28.69	27.99	27.33
16	.....	29.79	.....	27.09	28.59	27.94	27.24
17	.....	29.89	.....	27.24	28.64	28.04	27.24
18	.....	29.89	.....	27.44	28.59	27.94	27.30
19	.....	30.04	.....	27.34	28.69	27.74	27.07
20	.....	29.94	.....	27.29	28.79	27.49	27.22
21	.....	29.44	.....	27.74	28.54	27.44	27.07
22	.....	29.04	.....	27.94	28.59	26.09	28.14
23	29.99	29.14	.....	27.79	28.69	27.14	29.07
24	29.99	29.14	26.99	27.59	28.69	26.94	29.73
25	29.94	29.39	26.39	27.59	28.59	27.04	30.05
26	29.94	28.94	25.39	27.74	28.54	27.69	28.10
27	29.69	27.74	25.94	28.39	28.54	.....	28.70
28	29.79	27.29	26.14	28.74	28.99	27.36	29.16
29	29.64	27.34	26.69	28.64	.....	27.40	29.54
30	29.59	27.99	26.74	28.24	.....	28.13	29.70
31	29.44	.....	27.19	28.19	.....	29.00	.....

Fall of Mohawk River from Schenectady, gage No. 8, to Rexford Flats, gage No. 6.

Day.	1900.			1901.			
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.
1	0.09	0.02	0.66	0.21	0.41	0.11	0.86
2	.18	.15	.56	.31	.26	.06	.56
3	.17	.05	.36	.01	.26	.01	.56
4	.22	−.03	.26	.01	.21	.01	1.41
5	.17	.00	1.71	.41	.31	.06	1.56
6	.17	−.03	1.11	.21	.21	.11	1.46
7	.01	.10	.76	.16	.21	.26	1.51
8	.07	.07	.76	.41	.01	.21	3.16
9	.15	.25	.66	.16	.01	.16	1.96
10	.07	.39	.....	.16	.21	.11	1.71
11	.07	.41	.....	.36	.11	.45	1.36
12	.11	.11	.....	.41	.21	.56	1.01
13	.04	.06	.....	.69	.16	.86	1.11
14	.14	.11	.....	.43	.11	.61	1.11
15	−.05	.26	.....	.26	.06	.56	1.16
16	−.02	.11	.....	.08	−.04	.61	1.21
17	0	.06	.....	.01	.06	.61	1.11
18	0	.06	.....	.06	−.14	.51	1.03
19	.31	.11	.....	.10	−.14	.61	1.21
20	.24	.01	.....	.01	−.04	.81	1.01
21	0	.21	.....	.51	−.04	1.04	1.01
22	0	.56	.....	.04	.06	2.76	4.08
23	−.07	.51	.....	−.04	−.11	2.41	2.66
24	0	.46	−.09	.16	.06	1.51	2.41
25	.08	.21	.26	.11	.06	1.41	2.44
26	.12	.94	1.41	.16	.16	2.13	2.66
27	−.03	2.01	1.06	−.54	.06	2.39	1.11
28	−.20	1.91	.69	.18	.11	3.06	1.11
29	.21	1.66	.41	.56	.....	2.26	.76
30	−.03	.91	.36	.11	.....	1.51	.71
31	.04	.....	.26	.46	.....	.96	.....

Fall of Mohawk River from Hoffmans Ferry, gage No. 9, to Schenectady, gage No. 8.

Day.	1900.			1901.			
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.
1	.....	26.00	27.80	27.05	26.10	26.15	27.85
2	.....	26.10	27.55	26.70	26.20	26.05	27.55
3	.....	26.07	27.50	26.60	26.25	26.15	28.45
4	.....	25.80	27.45	26.35	26.20	26.20	28.30
5	.....	25.75	29.10	25.90	26.10	26.30	28.90
6	.....	25.63	28.05	26.60	26.50	26.85	28.75
7	.....	25.70	28.15	26.55	26.60	26.80	29.55
8	.....	25.87	28.10	26.35	26.80	26.55	28.10
9	.....	27.90	26.90	26.60	26.75	26.40	28.70
10	.....	27.30	27.30	26.65	26.75	26.90	28.35
11	.....	26.80	27.00	27.75	26.95	27.60	28.34
12	.....	26.55	27.25	27.25	26.45	28.05	28.50
13	.....	26.45	26.85	26.77	26.75	27.65	28.30
14	.....	26.35	26.70	27.08	27.30	27.50	28.50
15	.....	26.35	27.80	26.90	27.00	27.55	28.55
16	.....	26.25	28.80	26.83	27.20	28.00	28.45
17	.....	25.95	28.60	26.75	26.40	28.15	28.30
18	.....	26.05	28.30	26.55	26.25	27.70	28.33
19	.....	26.05	28.30	26.56	26.35	28.75	28.35
20	.....	26.90	28.40	26.80	26.25	28.75	28.30
21	.....	28.35	28.40	26.10	26.25	28.92	29.55
22	.....	27.75	28.10	26.45	26.20	29.00	23.33
23	.....	27.65	27.85	27.35	26.25	27.05	29.40
24	25.40	27.25	27.60	26.90	26.25	28.30	28.65
25	26.22	27.05	30.25	26.75	26.35	28.30	29.52
26	26.75	29.32	28.15	26.45	26.00	29.13	27.60
27	26.30	29.25	28.00	26.30	26.35	29.42	28.40
28	26.05	28.85	27.57	25.53	26.30	28.45	27.85
29	26.15	28.00	27.30	25.75	.....	28.30	28.00
30	26.15	27.95	27.25	26.55	.....	28.05	27.90
31	26.05	.....	27.00	26.25	.....	28.10	.....

Fall of Mohawk River from Amsterdam, gage No. 10, to Hoffmans Ferry, gage No. 9.

Day.	1900.			1901.			
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.
1	.....	12.84	11.94	13.14	14.54	14.24	11.84
2	.....	13.34	12.09	13.39	14.64	14.44	12.14
3	.....	13.34	12.19	15.04	14.59	14.39	11.94
4	.....	13.29	12.39	15.64	14.59	14.49	11.34
5	.....	13.49	11.39	15.44	14.64	14.39	11.19
6	.....	13.64	11.54	15.19	14.39	13.99	11.44
7	.....	13.64	11.74	15.19	14.14	13.89	11.39
8	.....	13.59	11.74	15.14	14.19	14.09	11.24
9	.....	12.39	12.94	15.09	14.04	14.44	11.29
10	.....	12.29	12.29	15.19	14.09	13.94	11.39
11	.....	12.74	12.74	14.74	13.89	13.74	11.39
12	.....	12.89	12.89	14.44	14.24	13.54	11.49
13	.....	13.14	12.64	14.64	13.94	13.34	11.59
14	.....	13.24	12.59	14.39	13.49	13.79	11.49
15	.....	13.24	12.09	14.39	13.64	13.69	11.49
16	.....	13.34	11.29	14.49	13.54	13.44	11.44
17	.....	13.54	12.04	14.44	14.14	13.29	11.59
18	.....	13.59	13.84	14.64	14.29	13.84	11.59
19	.....	13.59	13.99	14.49	14.29	13.54	11.49
20	.....	13.19	13.79	14.29	14.49	13.69	11.59
21	.....	12.09	13.54	14.19	14.39	13.74	12.49
22	.....	12.09	13.74	14.54	14.34	15.54	16.84
23	.....	12.14	13.84	14.39	14.44	15.29	11.64
24	13.89	12.34	13.89	14.49	14.29	12.64	11.19
25	13.79	12.59	12.69	14.39	14.24	11.94	10.19
26	12.89	11.69	12.89	15.24	14.44	10.94	10.99
27	13.09	11.64	12.99	14.94	14.29	11.54	11.39
28	13.34	11.29	13.29	14.44	14.24	12.14	.....
29	13.29	11.44	13.54	14.64	.....	11.19	.....
30	12.79	11.84	13.49	14.49	.....	11.39	.....
31	13.34	.....	13.34	14.49	.....	11.79	.....

Fall of Mohawk River from Fort Hunter, gage No. 13, to Amsterdam, gage No. 10.

Day.	1900.			1901.			
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.
1	.....	19.71	18.56	18.91	19.01	19.66	18.71
2	.....	19.01	18.81	18.96	19.06	19.56	18.86
3	.....	18.96	18.81	17.76	19.11	19.56	18.61
4	.....	19.31	19.51	17.66	19.21	18.36	18.36
5	.....	19.21	18.46	18.01	19.26	19.26	18.16
6	.....	19.11	18.26	18.01	19.21	19.06	18.06
7	.....	19.11	18.56	18.11	19.31	19.16	17.41
8	.....	19.06	18.66	18.21	19.11	19.26	17.06
9	.....	19.06	18.86	18.11	.....	19.11	17.96
10	.....	18.86	18.71	17.81	19.11	19.01	18.21
11	.....	18.81	19.06	17.21	19.21	18.26	19.06
12	.....	18.96	19.01	17.51	19.21	19.01	19.01
13	.....	18.96	19.36	17.51	19.26	19.06	18.97
14	.....	18.91	19.26	17.81	19.21	19.01	18.81
15	.....	18.96	19.31	18.11	19.31	18.96	18.71
16	.....	18.91	19.31	18.26	19.31	18.81	18.71
17	.....	18.91	18.86	18.31	19.36	19.01	18.81
18	.....	18.91	17.21	18.11	19.21	18.36	18.86
19	.....	18.76	17.11	18.31	19.21	17.96	18.86
20	.....	18.26	17.11	18.51	19.26	17.41	19.01
21	.....	16.86	17.21	18.91	19.31	17.76	17.36
22	.....	18.76	17.26	18.66	19.41	12.41	15.56
23	.....	19.01	17.51	17.96	19.36	14.61	16.61
24	.....	19.16	17.71	18.01	19.41	17.06	17.71
25	19.16	21.86	17.00	18.36	10.51	17.76	17.46
26	18.91	20.46	17.41	17.91	19.61	17.06	17.66
27	18.96	16.81	17.81	18.41	19.51	16.46	18.71
28	19.01	16.91	17.76	18.91	19.51	16.51	.....
29	19.01	17.31	17.96	18.81	.....	17.86	.....
30	19.46	18.06	18.26	18.91	.....	19.46	.....
31	19.06	.....	18.81	18.96	.....	18.66	.....

Fall of Mohawk River from Yosts, gage No. 14, to Fort Hunter, gage No. 13.

Day.	1900.			1901.			
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.
1	.....	8.53	10.08	9.03	8.13	7.98	10.13
2	.....	8.63	9.48	8.68	8.03	8.03	9.53
3	.....	8.63	9.28	8.38	8.03	8.13	10.53
4	.....	8.43	8.48	7.98	8.03	8.13	11.28
5	.....	8.28	10.53	7.98	8.03	8.28	11.13
6	.....	8.33	10.33	7.98	8.03	8.53	10.38
7	.....	8.43	10.13	8.03	8.23	8.33	10.08
8	.....	8.78	10.03	8.13	8.43	8.08	10.93
9	.....	9.93	9.93	8.33	.....	8.28	11.53
10	.....	9.48	9.28	9.53	8.33	9.08	11.18
11	.....	9.03	8.48	9.73	8.28	9.33	10.33
12	.....	8.73	9.88	9.73	8.13	8.58	10.03
13	.....	8.63	9.53	9.63	8.33	8.68	10.02
14	.....	8.58	9.98	9.38	8.33	8.63	10.38
15	.....	8.43	9.23	9.23	8.33	8.63	10.78
16	.....	8.38	8.98	9.03	8.28	8.03	10.83
17	.....	8.38	8.98	9.18	8.18	8.83	10.48
18	.....	8.33	9.03	9.53	8.18	9.13	10.63
19	.....	8.68	8.98	9.23	8.13	10.38	10.68
20	.....	10.08	9.33	8.73	8.28	9.83	10.38
21	.....	12.23	9.38	8.43	8.20	10.48	9.48
22	.....	10.08	9.28	8.73	8.13	12.73	9.83
23	.....	9.63	9.03	9.28	8.23	13.58	.....
24	.....	9.23	9.13	9.28	8.13	13.63	11.68
25	.....	6.18	10.53	8.98	8.08	13.73	10.03
26	.....	10.63	10.88	8.78	8.03	14.03	9.53
27	.....	13.53	10.28	8.53	8.13	14.43	9.23
28	.....	14.23	9.98	8.38	8.13	13.88	.....
29	8.83	12.38	9.58	8.28	.....	12.33	.....
30	8.63	11.23	9.13	8.13	.....	10.53	.....
31	8.58	.....	8.93	8.13	.....	10.48	.....

Fall of Mohawk River from Canajoharie, gage No. 15, to Yosts, gage No. 14.

Day.	1900.			1901.			
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.
1	.....	9.79	8.14	9.59	8.69	8.54	8.89
2	.....	9.34	9.59	9.19	8.69	8.59	10.14
3	.....	9.39	8.44	8.69	8.69	8.49	9.14
4	.....	9.64	8.94	9.19	8.64	8.54	8.49
5	.....	9.44	7.34	8.89	8.59	8.59	8.39
6	.....	9.49	8.34	8.74	8.59	8.44	8.39
7	.....	8.78	8.99	8.69	8.59	8.54	8.31
8	.....	9.35	8.69	8.99	8.09	8.69	8.09
9	.....	9.99	8.59	8.39	8.04	8.59	8.34
10	.....	9.04	9.54	9.19	8.19	8.59	8.44
11	.....	9.94	10.74	9.39	8.24	8.69	8.39
12	.....	9.24	9.84	8.69	8.39	8.39	8.44
13	.....	9.44	12.14	9.09	8.19	8.44	8.69
14	.....	9.64	11.24	8.69	8.19	8.69	8.84
15	.....	9.69	10.29	8.79	8.19	8.74	8.94
16	.....	9.24	11.19	8.49	8.24	8.44	8.79
17	.....	9.34	11.14	7.89	8.49	10.29	8.69
18	.....	9.56	9.59	7.27	8.59	8.59	8.99
19	.....	9.69	9.14	7.57	8.69	7.44	8.84
20	.....	8.89	9.79	8.29	8.59	7.64	8.69
21	.....	7.97	9.54	8.74	8.59	8.69	8.74
22	.....	7.74	9.34	9.09	8.69	7.64	7.49
23	.....	8.94	9.79	8.44	8.59	7.89	.....
24	.....	9.19	9.79	8.14	8.64	7.44	8.09
25	.....	9.24	9.49	8.54	8.44	7.44	7.89
26	.....	8.99	9.99	8.34	8.64	5.69	8.69
27	.....	8.04	9.59	8.59	8.59	6.94	8.99
28	.....	8.09	9.64	8.74	8.44	7.79	.....
29	9.19	8.64	9.34	8.59	.....	8.09	.....
30	9.24	8.39	9.59	8.69	.....	8.69	.....
31	9.99	.....	9.74	8.69	.....	8.89	.....

Fall of Mohawk River from St. Johnsville, gage No. 16, to Canajoharie, gage No. 15.

Day.	1900.			1901.			
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.
1	.....	12.69	13.69	12.39	13.69	.....	12.74
2	.....	13.09	12.49	12.84	13.89	.....	11.89
3	.....	12.94	13.64	13.39	13.84	13.59	12.44
4	.....	12.74	13.39	13.09	13.84	13.59	12.44
5	.....	12.99	13.84	13.54	13.99	13.34	12.14
6	.....	12.99	13.29	13.74	14.19	13.24	13.09
7	.....	13.75	12.89	13.49	14.29	13.34	12.47
8	.....	15.08	13.24	13.34	14.39	13.44	12.49
9	.....	12.94	12.84	13.69	14.19	13.49	12.94
10	.....	13.79	12.44	12.99	14.09	12.94	12.49
11	.....	12.39	11.44	12.69	14.09	12.74	12.44
12	.....	13.09	11.24	13.24	13.99	12.49	12.74
13	.....	12.99	9.19	12.69	13.99	12.64	12.79
14	.....	12.89	9.29	13.19	13.99	12.64	.....
15	.....	13.04	12.89	12.99	13.99	12.64	.....
16	.....	13.24	11.94	13.39	13.99	12.64	.....
17	.....	13.14	11.79	14.04	13.74	10.69	.....
18	.....	12.92	12.94	14.66	13.74	12.44	.....
19	.....	13.64	13.64	14.31	13.69	13.09	.....
20	.....	14.99	12.84	13.89	13.74	12.94	.....
21	.....	15.19	12.99	13.69	13.69	12.24	.....
22	.....	15.09	12.69	13.64	13.69	12.09	.....
23	.....	13.79	12.29	13.74	13.49	13.94	.....
24	.....	13.09	13.09	13.84	.....	15.39	.....
25	.....	13.74	12.54	13.49	.....	15.14	.....
26	.....	14.24	11.89	13.79	.....	14.99	.....
27	.....	13.54	12.14	13.69	.....	13.94	.....
28	13.19	13.14	12.04	13.59	.....	13.14	.....
29	13.24	12.24	12.39	13.84	.....	12.79	.....
30	13.09	12.84	12.59	13.89	.....	12.59	.....
31	12.34	.....	12.39	13.79	.....	12.59	.....

Fall of Mohawk River from Rocky Rift dam, gage No. 17, to St. Johnsville, gage No. 16.

Day.	1900.			1901.			
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.
1	.....	17.73	17.49	.....	16.78	.....	16.93
2	.....	17.81	17.48	.....	16.63	.....	17.38
3	.....	17.78	17.53	.....	16.68	17.03	16.83
4	.....	17.88	17.43	.....	16.73	16.98	17.13
5	.....	17.91	16.73	.....	16.73	16.98	16.98
6	.....	17.93	17.53	.....	16.63	17.08	16.78
7	.....	17.86	18.33	.....	16.63	17.18	16.73
8	.....	18.35	17.83	17.48	16.63	17.48	16.73
9	.....	17.33	17.73	16.63	16.88	17.33	17.73
10	.....	16.98	17.93	16.98	16.88	17.33	17.58
11	.....	17.66	17.93	17.08	16.83	17.18	17.38
12	.....	17.73	17.73	17.03	16.93	17.03	17.23
13	.....	17.83	17.48	17.18	17.03	16.73	17.13
14	.....	17.76	17.78	17.08	17.33	16.68	.....
15	.....	17.63	15.71	17.08	17.18	17.03	.....
16	.....	17.93	15.93	17.03	16.93	16.73	.....
17	.....	17.93	16.16	16.98	16.93	16.78	.....
18	.....	17.98	16.51	16.08	16.83	17.23	.....
19	.....	17.23	16.43	16.78	16.83	16.88	.....
20	.....	16.98	16.53	16.98	16.68	17.78	.....
21	.....	16.76	16.58	16.58	16.68	17.38	.....
22	.....	16.28	17.18	16.13	16.63	16.08	.....
23	.....	16.96	17.28	16.63	16.78	15.08	.....
24	.....	17.48	17.43	16.53	.....	13.38	.....
25	.....	18.23	16.63	16.43	.....	13.43	.....
26	.....	16.42	16.68	17.03	.....	14.78	.....
27	.....	17.03	17.03	16.78	.....	14.08	.....
28	17.66	17.03	17.48	16.68	.....	14.58	.....
29	17.76	18.23	17.23	16.63	.....	16.58	.....
30	17.78	17.43	16.98	16.63	.....	17.18	.....
31	18.08	.....	17.31	16.73	.....	17.18	.....

Fall of Mohawk River from surface of tailrace, Little Falls Paper Company's mill, Little Falls, N. Y., to water surface above Rocky Rift dam.

Day.	1900.			1901.			
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.
1	.....	0.44	0.90	.....	0.80	2.32	1.55
2	.....	.42	1.22	.....	.80	2.32	.79
3	.....	.54	.57	.....	.80	2.42	.80
4	.....	.59	.64	.....	.80	2.52	.97
5	.....	.64	1.92	.....	.72	2.52	1.57
6	.....	.67	1.82	.....	.72	2.52	2.67
7	.....	.57	1.15	.....	.72	2.42	2.64
8	.....	−.11	1.04	0.07	.72	2.30	2.70
9	.....	.69	1.42	−.06	.72	2.39	3.27
10	.....	1.12	.44	−.16	.77	2.29	3.07
11	.....	.75	.42	−.21	.74	2.14	2.99
12	.....	.95	.32	−.08	.84	2.14	1.22
13	.....	.40	.37	.34	.79	1.72	1.50
14	.....	.42	.39	.49	.64	1.55	1.05
15	.....	.47	.37	.80	.64	1.50	1.04
16	.....	.22	.45	.92	.77	1.45	1.29
17	.....	.34	.37	.60	.79	1.50	1.14
18	.....	.32	.40	.64	.84	1.20	1.52
19	.....	.40	.32	.84	.79	.55	1.85
20	.....	.50	.37	.67	.94	1.05	1.70
21	.....	1.24	.34	.52	1.37	.37	2.27
22	.....	1.42	.47	.49	1.92	2.59	1.97
23	.....	1.39	.42	.39	2.22	3.52	4.60
24	.....	.85	.49	.69	2.22	3.62	1.45
25	.....	2.22	.52	.64	2.22	3.57	2.39
26	.....	2.80	.42	.65	2.22	4.22	2.25
27	.....	3.97	.62	.75	2.22	5.17	2.21
28	0.62	3.77	.02	.80	2.22	6.47	2.39
29	.49	3.47	.94	.80	.....	6.97	2.17
30	.59	4.39	.94	.55	.....	5.89	1.89
31	.52	.....	.89	.50	.....	1.47	.....

Fall of Mohawk River from Herkimer, gage No. 24, to Little Falls, above Gilbert's dam, gage No. 23.

Day.	1900.			1901.			
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.
1	.....	11.70	15.20	.....	13.80	18.80	13.10
2	.....	11.45	12.50	.....	14.60	17.70	13.85
3	.....	10.95	13.00	.....	14.40	17.10	14.65
4	.....	.....	13.55	.....	13.80	16.60	14.35
5	.....	.....	13.10	.....	13.60	15.70	14.80
6	.....	12.00	14.00	.....	13.40	15.80	15.10
7	.....	12.55	13.85	.....	13.80	14.80	15.25
8	.....	12.80	12.75	13.70	14.40	14.80	15.15
9	.....	13.00	12.50	13.35	14.70	19.70	14.70
10	.....	12.60	12.80	13.25	14.40	13.10	14.55
11	.....	12.25	13.10	13.70	14.45	14.20	14.95
12	.....	11.95	12.90	14.20	14.20	14.15	14.65
13	.....	11.50	13.50	13.60	14.10	14.10	14.15
14	.....	11.40	13.65	13.70	13.35	13.20	13.55
15	.....	11.25	13.85	13.40	13.10	12.70	13.20
16	.....	11.75	13.55	13.65	12.65	13.20	13.00
17	.....	11.85	13.85	14.20	13.10	13.75	13.00
18	.....	11.75	13.85	13.95	13.10	14.30	12.75
19	.....	11.95	14.95	14.30	13.20	14.90	12.80
20	.....	11.75	15.20	14.45	13.45	16.65	13.00
21	.....	11.65	15.05	14.85	13.60	17.30	.....
22	.....	12.95	14.90	14.65	13.35	15.10	.....
23	.....	13.55	14.50	13.50	13.00	14.10	.....
24	.....	14.00	13.95	12.70	12.90	14.50	.....
25	.....	14.35	14.35	12.50	12.70	15.25	.....
26	.....	15.15	13.90	13.20	12.70	15.75	.....
27	.....	15.85	13.85	13.45	19.80	15.60	.....
28	11.40	15.65	14.10	13.50	18.80	15.60	.....
29	11.20	16.00	13.60	14.10	.....	15.70	.....
30	11.00	15.25	.....	14.45	.....	16.25	.....
31	11.05	.....	.....	14.30	.....	12.85	.....

In order to reduce the observed gage readings and obtain the corresponding rates of discharge, the method outlined below was pursued.

From the well-known Chezy formula—

$$Q = AV \tag{1}$$

$$V = C\sqrt{RS} \tag{2}$$

$$R = \frac{A}{P} \tag{3}$$

Q = discharge of stream in second-feet.

A = area of channel cross section, square feet.

V = mean velocity of flow in feet per second.

S = the sine of the surface slope, for which, owing to its small value, the surface slope has been substituted.

R = hydraulic radius or hydraulic mean depth of the channel.

P = wetted perimeter or circumference of the stream cross section exposed to friction.

C is a variable coefficient.

The lengths of the reaches of the stream covered by the several slope sections are shown in the accompanying table. Using the known elevations of the gage zeros, a series of tables of mean daily fall from gage to gage have been prepared by means of the formula:

Fall = Difference of elevation of gage zeros (+reading of upper gage, −reading of lower gage). (4)

These tables show at once the great variations in the rate of fall under varying stages, or when affected by wind, ice, backwater, or sudden rising or falling of the stream.

Data was then computed for each section from which a diagram could be prepared showing the value of $\sqrt{S}$ from the formula:

$$S=\frac{F}{L} \tag{5}$$

F=fall in feet.
L=constant length of the slope section in feet.

These curves have a range equal to the observed range of variation in fall, and from them a second series of tables showing the value of $\sqrt{S}$ for each day were made out.

To determine the area of cross section, wetted perimeter, and hydraulic radius the topographic maps of Mohawk River prepared by United States Board of Engineers on Deep Waterways were available. These maps show cross sections of the stream channel taken at an average interval of 300 feet, from Hudson River to Rome. In making the cross sections soundings were taken at average intervals of 25 feet across the channel. The elevations of the stream bed so determined have been reduced to the datum to which the positions of the slope gages are referred.[a]

To utilize the information at hand in such a manner as to attain the true mean cross section for each slope section, the average elevation of the stream bed below low-water mark was determined. In doing this every alternate cross section, or in critical locations, every section was copied from the maps and the average of the soundings taken. In this way the elevations of a series of assumed horizontal cross sections at a large number of points in each slope section were obtained. The average of these has been used as the mean elevation of the stream bed for each slope section. In a similar manner the average width of the stream bed below low-water mark was determined from the cross-sections for each slope section.

A third series of tables were prepared from the gage readings, showing the average of the elevations of the water surface at the upper and lower ends of each slope section for each day. This was taken as the elevation of the mean water surface above the mean stream bed previously determined.

The side slopes of the channel above the low-water mark were found to have an average inclination of very nearly 1:1. A series of curves were prepared, one for each slope section, showing the area of cross section corresponding to any mean elevation of water surface as given in the tables. The formula for area of cross section is as follows:

$$A = (W + D)D \tag{6}$$

W = width of stream bed, feet.
D = difference of elevation of stream bed and mean water surface, feet.

[a] The methods of cross sectioning the channel and of taking the Mohawk River soundings are described in a paper by D. J. Howell, C. E., in Engineering News, Vol. XLIII, pp. 402-405, 418-422.

A series of values of the wetted perimeter of the cross section were then found by the formula

$$P = W + 2\sqrt{2D} + \tfrac{1}{2}(W + 2D) \qquad (7)$$

The factor, $\frac{1}{2}(W+2D)$, represents one-half of the area of the exposed water surface, which was added to the perimeter in earth to allow for the effect of wind and air friction in open weather, and of friction on the ice coating when the stream surface was frozen. The proper value for this quantity is quite uncertain, as the extent to which the stream was frozen over varied greatly at different times. From the gage readers' reports it was found that there were marginal strips of ice along both banks during several months of the winter season, the width of the strips increasing so as to cover the entire surface on mill ponds or in places where the current was sluggish, and diminishing in extent over rifts or in narrows. The fraction one-half was selected as best representing the average condition during the entire period while the gagings were being kept. Finally a diagram was prepared for each slope section, showing values of R for any elevation of the mean water surface.

The value of the coefficient C varies with the slope and hydraulic radius. It is also a function of the general character of the stream channel, including the roughness of the material composing the stream bed, the frequency of bends, their abruptness, the occurrence of islands or sudden changes in cross section, the presence of aquatic plants, etc. These factors are all summed up in terms of the "degree of roughness" of the channel, usually expressed by the letter n. This has been assigned the value 0.0325, the stream during high water being considered as having fairly good regimen when expressed in terms of the usual hydraulic scale; so that n=.030 would apply to the better slope sections, which only have been computed. When obstructed by ice or during low water n=.035 could properly be used. For the sake of uniformity the mean of the two values has been adopted. To determine C the diagram of Hering and Trautwine was used.[a]

Having given the fall and the elevation of the mean water surface for each day, it was only necessary to take from the diagrams the values of the factors A, $C\sqrt{R}$, and S, which, when multiplied together, give the rate of discharge. The labor of this multiplication was greatly lessened by the use of Crelle's Tables.[b]

The discharge has been calculated only for those slope sections considered to possess the most perfect regimens. Owing to variations in the area of cross section, irregularities in the stream channel, etc., the surface slope is much more nearly uniform for high water than for lower stages, and the results of the calculations are proportionally

[a] Flow of Water, etc., by Ganguillet and Kutter, translated by Rudolph Hering and John C. Trautwine.

[b] Rechentafeln, by A. L. Crelle, containing the products of all factors from 1 to 1,000.

more reliable. As noted above, gage readings taken in winter were taken to the surface of water rising in a hole through the ice. It has not been practicable to correct the stream cross sections by deducting the thickness of ice below water surface as should properly be done.

In making the final computations it was found impracticable to work out the flow for each day, or indeed for any but extreme stages from these records, for the reason that the presence of slack water in eddies and bays and of rifts and sudden changes of slope at all lower stages make the apparent cross section and grade much greater than the effective elements. The greater velocities, due to high water, cause these sources of error largely to disappear.

The slope gagings were originally established by the Barge Canal survey in 1900 for the purpose of determining the maximum discharge of the Lower Mohawk, and for such maximum stages of the stream the results are fairly reliable, and are of interest in reference to the effect of floods on the proposed barge canals in the Mohawk Valley. The tables of mean daily elevation and fall of the river from gage to gage are of interest in the same connection, showing the development and progress of floods.

HIGH-WATER DISCHARGE OF MOHAWK RIVER ESTIMATED FROM GAGINGS OF SURFACE SLOPE.

St. Johnsville-Canajoharie section.

[Mean drainage area, 1,775 square miles.]

Date.	Estimated discharge.	Discharge per square mile.
FLOOD OF NOVEMBER 27, 1900.		
1900.	*Second-feet.*	*Second-feet.*
Nov. 25	4,500	2.5
26	15,480	8.7
27	17,320	9.7
28	16,100	9.1
29	9,280	5.2
30	6,970	3.9
FLOOD OF MARCH 27, 1901.		
1901.		
Mar. 25	15,842	8.9
26	15,576	8.8
27	21,376	12.0
28	19,442	10.9
29	12,628	7.1
FLOOD OF APRIL 8, 1901.		
1901.		
Apr. 8	12,312	6.9
9	11,745	6.6
10	10,449	5.9

Canajoharie—Yosts section.

[Mean drainage area, 1,933 square miles.]

FLOOD OF NOVEMBER 27, 1900.

Date.	Estimated discharge.	Discharge per square mile.
1900.	*Second-feet.*	*Second-feet.*
November 27	18,271	9.4
28	18,088	9.3
29	12,948	6.7

FLOOD OF MARCH 27, 1901.

1901.		
March 24	15,038	7.8
25	15,184	7.9
26	14,364	7.4
27	25,860	13.4
28	27,110	14.0
29	15,504	8.0

FLOOD OF APRIL 8, 1901.

1901.		
April 6	12,865	6.7
7	14,553	7.5
8	16,656	8.6
9	15,554	8.0
10	13,797	7.1

Fort Hunter—Amsterdam section.

[Mean drainage area, 3,145 square miles.]

FLOOD OF NOVEMBER 27, 1900.

Date.	Estimated discharge.	Discharge per square mile.
1900.	*Second-feet.*	*Second-feet.*
November 26	14,580	4.6
27	17,763.5	5.6
28	14,022	3.3
29	8,341	2.7

FLOOD OF MARCH 27, 1901.

1901.		
March 24	12,597	4.0
25	11,460	3.6
26	17,660	5.6
27	25,515	8.1
28	23,206	7.4
29	14,420	4.6

Fort Hunter—Amsterdam section—Continued.

FLOOD OF APRIL 8, 1901.

Date.	Estimated discharge.	Discharge per square mile.
1901.	*Second-feet.*	*Second-feet.*
April 6	14,535	4.6
7	19,000	6.0
8	21,625	6.9
9	16,385	5.2
10	13,132	4.2

FLOOD OF APRIL 22, 1901.

1901.		
April 20	8,610	2.7
21	13,695	4.4
22	32,276	10.3
23	28,060	8.9
24	19,404	6.2
25	24,075	7.7
26	17,068	5.4

Rexford Flats—Vickers Ferry section.

[Mean drainage area, 3,369 square miles.]

FLOOD OF NOVEMBER 27, 1900.

Date.	Estimated discharge.	Discharge per square mile.
1900.	*Second-feet.*	*Second-feet.*
November 26	14,787	4.3
27	30,176	8.9
28	27,018	6.1

FLOOD OF MARCH, 1901.

1901.		
March 25	20,041	5.9
26	31,800	9.3
27		
28	37,288	11.0
29	27,650	8.1

FLOOD OF APRIL 9, 1901.

1901.		
April 1	36,079	10.6
8	37,366	11.0
9	37,848	11.1
10	38,533	11.3

FLOOD OF APRIL 22, 1901.

1901.		
April 21	17,955	5.2
22	60,990	17.93
23	45,966	13.4
24	41,250	12.1

MIDDLE ATLANTIC COAST DRAINAGE.

PASSAIC RIVER, NEW JERSEY.

Passaic River has its rise in Somerset and Morris counties, N. J. Above its confluence with Pompton River, its main tributary, it meanders through a flat country of Triassic red sandstones, to which in large measure must be attributed the turbidity of its waters. In contrast with the sluggish, muddy character of the Passaic, the Pompton is a rapid stream and its waters are clear. It drains parts of Sussex, Passaic, and Morris counties, and traverses for a large part of its course a country of hard crystalline rocks and heavy forests, the general level of which is several hundred feet above that of the Passaic. At their confluence the Pompton enters with a current which carries it well toward the right bank of the Passaic, and at times of flood causes much backwater in the latter.

The flow of Passaic River is of special interest from the fact that several large cities in its drainage basin take their public water supply from it, and because of the valuable water-power privileges along its course, particularly at the city of Paterson. Several cities, including Paterson and Passaic, throw their sewage into this stream, and in the lower part of its course it becomes so polluted as to be offensive to property holders along its banks and to seriously interfere with the comfort and pleasure of the inhabitants of several towns.

Measurements of the flow over the dam at Paterson have been made for several years, but the data are not available for publication.

PASSAIC RIVER AT TWO BRIDGES, N. J.

This station was established May 2, 1901, by George B. Hollister, just above the confluence with Pompton River. Discharge measurements are made from a wagon bridge. The gage consists of a vertical pine board, marked in feet and tenths, spiked to the protecting timber on the upstream side of the first pier from the left bank. The bench mark is the top of the capstone of this pier, and its elevation is 13.65 feet above the datum of the gage. The channel is straight for some distance above and below the bridge. The bottom is gravelly. The right bank is about 10 feet high, while the left bank is lower and liable to overflow.

The flood of August 26, 1901, is considered the highest that has occurred during the last five years.

Discharge measurements of Passaic River at Two Bridges, N. J.

Date.	Hydrographer.	Gage height.	Discharge.
1901.		*Feet.*	*Sec. feet.*
May 4	George B. Hollister	3.88	1,345
Do	do	4.20	1,198
May 24	do	3.05	626
June 15	do	2.50	522
July 11	do	2.20	337
August 15	do	2.75	589
August 26	do	9.35	3,882
October 26	do	2.20	230
November 23	do	1.92	181

Daily gage height, in feet, of Passaic River at Two Bridges, N. J., for 1901.

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	4.75	1.80	2.75	4.95	3.15	2.00	2.00
2	3.90	4.55	2.10	2.50	4.80	3.00	2.00	2.00
3	4.25	4.55	2.30	2.50	4.40	3.00	2.00	2.05
4	4.20	4.30	2.70	2.50	4.10	3.00	2.00	2.60
5	4.05	3.95	3.10	2.30	3.75	2.85	2.00	2.95
6	3.60	3.65	3.60	2.30	3.50	2.65	2.00	2.85
7	3.30	3.45	3.65	4.20	3.20	2.45	2.00	2.70
8	3.05	4.35	3.45	4.80	3.00	2.40	2.00	2.65
9	2.95	4.05	2.70	4.00	2.90	2.30	2.00	2.50
10	3.65	3.85	2.25	3.70	2.60	2.25	2.00	2.40
11	5.65	3.40	2.20	3.45	2.50	2.20	2.00	2.95
12	5.60	3.15	2.45	3.25	2.60	2.20	2.05	2.85
13	5.15	2.95	2.55	3.05	2.60	2.20	2.20	2.80
14	4.85	3.00	2.50	3.00	2.55	2.85	2.30	2.85
15	4.45	2.50	2.30	2.75	2.45	3.55	2.10	3.20
16	4.05	2.40	2.25	2.50	2.65	3.45	2.10	6.80
17	3.90	2.30	2.40	2.50	2.85	3.20	2.10	5.90
18	3.40	2.15	3.55	4.10	2.80	2.95	2.10	5.15
19	3.50	1.95	2.60	5.55	2.65	2.80	2.00	4.85
20	2.95	1.95	2.50	5.20	2.50	2.60	2.00	4.20
21	3.15	1.90	2.15	4.50	2.45	2.50	2.00	3.00
22	3.00	1.85	2.00	6.15	2.40	2.50	2.00	3.00
23	3.00	1.90	2.00	6.00	2.20	2.20	1.90	2.95
24	3.05	2.00	2.00	7.05	2.20	2.20	2.35	2.70
25	3.25	2.05	2.00	9.30	2.20	2.20	2.65	2.55
26	3.60	1.90	2.00	8.50	2.10	2.10	3.05	2.40
27	3.95	1.90	2.00	7.35	2.10	2.05	3.00	3.20
28	4.40	1.80	2.00	6.35	2.10	2.00	3.00	3.80
29	4.40	1.80	2.20	5.45	2.40	2.00	2.65	3.70
30	4.65	1.80	2.70	5.00	3.35	2.00	2.30	8.70
31	4.90	.....	2.75	5.10	.....	2.00	.....	10.45

POMPTON RIVER AT TWO BRIDGES, N. J.

A station was established May 2, 1901, by George B. Hollister, on Pompton River just above its junction with Passaic River, a point 2 miles south of the railroad station at Mountain View, N. J., and 2½ miles west of Littlefalls, N. J. Measurements are made from a wagon bridge. The gage is a vertical pine board, marked in feet and tenths, spiked to the middle masonry pier on the downstream side. The bench mark is the top of the capstone of the same pier, and its elevation is 10.7 feet above the datum of the gage. The channel, which is gravelly, is straight for some distance above and below the bridge, the banks on both sides being about 8 feet high and subject to overflow at times of freshets only.

The flood of August 26, 1901, is considered the highest that has occurred during the last five years.

Discharge measurements of Pompton River at Two Bridges, N. J.

Date.	Hydrographer.	Gage height.	Discharge.
1901.		*Feet.*	*Sec.-feet.*
May 4	George B. Hollister	3.35	1,837
May 24	do	2.20	952
June 15	do	1.60	543
July 11	do	1.35	304
August 15	do	1.78	350
August 26	do	8.32	5,425
October 26	do	1.30	283
November 22	do	1.00	195

Daily gage height, in feet, of Pompton River at Two Bridges, N. J., for 1901.

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1		3.90	1.20	1.70	4.00	2.30	1.10	1.30
2	3.10	3.75	1.85	1.45	3.80	2.00	1.10	1.30
3	3.50	3.70	2.05	1.55	3.50	2.00	1.10	1.35
4	3.35	3.40	2.25	1.35	2.95	2.00	1.10	1.75
5	2.95	3.05	2.45	1.20	2.60	1.75	1.10	1.90
6	2.65	2.80	2.60	1.20	2.45	1.65	1.10	1.95
7	2.45	2.60	2.65	3.25	2.20	1.50	1.10	1.75
8	2.15	3.51	2.65	3.90	2.00	1.40	1.10	1.70
9	2.20	3.50	1.85	3.15	2.85	1.30	1.10	1.60
10	2.85	2.80	1.50	2.65	1.65	1.30	1.10	1.16
11	4.50	2.45	1.30	2.45	2.65	1.30	1.10	2.25
12	4.70	2.15	1.45	2.25	2.65	1.30	1.15	2.05
13	4.30	1.95	1.60	2.05	1.70	1.25	1.25	1.00
14	3.60	1.60	1.60	2.00	1.50	1.95	1.45	2.45
15	3.55	1.50	1.40	1.85	1.50	2.55	1.20	3.40
16	3.20	1.50	1.15	1.55	1.85	2.45	1.20	5.90
17	2.85	1.45	1.35	1.50	2.05	2.30	1.20	4.90
18	2.60	1.45	2.65	3.20	2.00	2.15	1.20	4.20
19	2.65	1.25	1.65	4.55	2.00	2.00	1.10	3.90
20	2.45	1.20	1.60	4.25	1.85	1.75	1.10	3.65
21	2.50	1.15	1.20	3.60	1.45	1.60	1.00	3.30
22	2.15	1.00	1.00	5.15	1.40	1.50	1.00	3.10
23	2.30	1.00	1.00	5.00	1.40	1.40	1.00	2.60
24	2.15	1.15	1.00	6.50	1.40	1.30	1.10	1.95
25	2.40	1.10	1.00	8.25	1.30	1.30	1.65	1.80
26	2.75	1.15	1.00	7.15	1.20	1.30	2.30	1.55
27	2.80	.90	1.00	6.10	1.10	1.25	1.95	2.35
28	3.50	.90	1.00	5.15	1.10	1.20	1.90	2.70
29	3.50	.90	1.30	4.55	1.50	1.20	1.70	2.80
30	4.00	.90	1.75	4.05	2.50	1.10	1.55	7.10
31	4.00		1.75	3.85		1.10		9.60

STREAM MEASUREMENTS IN SOUTHERN NEW JERSEY.

During the months of July and August, 1901, a number of streams were measured in southern New Jersey by George A. Mitchell, with a view to ascertaining the availability of water for irrigation purposes. In this part of the State there are sections of waste, sandy lands, incapable of producing any crops or timber except where fertilizer and water are applied. During the last few years small plants for pumping water for irrigation have been installed in southern New Jersey, the area so benefited being in most cases used for truck gardening, and the results obtained have been very gratifying. Power is usually obtained by means of gasoline engines and the water supply derived either from streams or from wells.

TUCKAHOE RIVER, NEW JERSEY.

Tuckahoe River is the southernmost stream of importance in New Jersey draining directly into the Atlantic Ocean, its mouth being at

Great Egg Harbor. Partial deforestation of its drainage basin is the cause of much fluctuation in the flow of this river in recent years. At Hunter's mill, about 7½ miles below its source, there are said to be fairly good opportunities for the storing of flood waters. The following measurements were made at Hunter's mill, New Jersey, during April, 1901, by George A. Mitchell:

July 23: Gage height, 1.45 feet; discharge, 14 second-feet.
August 18: Gage height, 1.85 feet; discharge, 25 second-feet.
August 21: Gage height, 1.52 feet; discharge, 14 second-feet.

MANANTICO CREEK, NEW JERSEY.

Manantico Creek is one of the principal tributaries of Maurice River, which drains into Delaware Bay. It flows through a district containing several thousand acres of farming and sandy lands so situated as to be readily irrigated with its waters by diverting the latter at suitable points. In the case of this creek no mills have made use of water power for a long term of years, and the prospects of appropriating water rights for irrigation are therefore favorable.

The following discharge measurements of Manantico Creek and of Parvins, Manaway, and Blackwater branches, three small tributaries that enter Maurice River above Millville, N. J., were made during 1901 by George A. Mitchell:

Miscellaneous discharge measurements of Manantico Creek and other tributaries of Maurice River, New Jersey.

Date.	Stream.	Locality.	Gage height.	Discharge.
1901.			*Feet.*	*Sec. feet.*
July 20	Manantico Creek	Hance's bridge	2.1	23
Do	do	Leaming's mills	14.3	36
July 25	Parvins Branch	Malaga road	1.7	2
July 26	Blackwater Creek	West boulevard	1.5	4
Do	Manaway Branch	Above Malaga	0.38	4
July 27	Parvins Branch	East avenue	0.27	0.3
August 6	do	do	1.51	7
August 7	Manantico Creek	Hance's bridge	2.45	36
Do	do	Leaming's mills	1.3	56
August 14	Blackwater Creek	West boulevard	2.7	12
Do	Manaway Branch	Malaga road	1.3	22
August 19	Manantico Creek	Leaming's mills	2.0	75
Do	Manaway Branch	Malaga road	2.2	54
Do	Blackwater Creek	West boulevard	4.3	71
Do	Parvins Branch	Malaga road	5.0	14
Do	do	East avenue	3.2	32
August 21	Manantico Creek	Leaming's mills	2.3	105

LEHIGH RIVER NEAR BETHLEHEM, PA.

The gage heights of Lehigh River, read on the gage at the old bridge between Bethlehem and South Bethlehem, Pa., were furnished through the courtesy of Prof. M. Merriman, of Lehigh University.

Daily gage height, in feet, of Lehigh River near Bethlehem, Pa., for 1901.

Day.	Aug.	Sept.	Oct.	Nov.	Dec.	Day.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	3.5	3.5	2.6	2.3	17	.....	2.8	3.2	2.5	5.5
2	.....	3.4	.....	2.5	2.5	18	.....	2.8	3.1	2.5	4.1
3	.....	3.3	.....	2.5	2.7	19	.....	3.0	3.1	2.3	.....
4	.....	3.3	.....	2.5	2.9	20	.....	.....	3.0	2.3	.....
5	.....	3.1	.....	2.5	2.6	21	.....	2.9	2.9	.....	.....
6	.....	3.0	.....	2.5	2.5	22	.....	.....	2.8	2.2	.....
7	.....	3.0	2.8	2.5	2.5	23	.....	2.7	2.8	2.3	.....
8	.....	2.9	.....	2.5	2.6	24	12.5	2.7	2.8	2.5	.....
9	.....	2.8	2.7	2.5	2.7	25	10.7	2.7	2.8	2.8	.....
10	.....	2.8	2.7	.....	3.7	26	6.1	.....	2.7	2.8	.....
11	.....	2.8	2.7	2.4	4.3	27	4.8	.....	2.7	2.3	.....
12	.....	2.8	2.7	2.5	3.7	28	4.2	.....	2.7	.....	.....
13	.....	2.8	3.4	2.8	3.4	29	3.7	.....	2.6	.....	6.0
14	.....	2.8	3.2	2.7	.....	30	3.5	3.6	.....	.....	.....
15	.....	2.8	3.5	2.6	15.5	31	3.5	.....	2.6	.....	.....
16	.....	2.8	3.2	2.5	8.3						

DELAWARE RIVER AT LAMBERTVILLE, N. J.

This station was established July 23, 1897, by E. G. Paul, and is described in Water-Supply Paper No. 47, page 80. Results of measurements, including the flow of the Delaware and Raritan Canal feeder, for 1900 will be found in the Twenty-second Annual Report, Part IV, page 112. During 1901 the following measurements of discharge were made by Mr. Paul:

August 31: Gage height, 5.07 feet; discharge, 17,217 second-feet.
October 30: Gage height, 3.65 feet; discharge, 6,667 second-feet.

A measurement was made of Bushkill River, a tributary of the Delaware, at Bushkill, Pa., on October 25, 1901, when the discharge was found to be 118 second-feet.

Daily gage height, in feet, of Delaware River at Lambertville, N. J., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.90	([a])	([a])	5.70	5.55	8.20	3.30	3.60	5.10	4.60	3.60	3.70
2	3.80	([a])	([a])	5.40	5.25	7.25	3.20	3.70	5.05	4.60	3.60	3.65
3	4.05	([a])	([a])	5.65	5.50	7.00	3.05	3.35	5.50	4.50	3.60	3.85
4	([a])	([a])	2.90	6.05	6.00	6.70	3.10	3.15	5.45	4.30	3.50	4.30
5	([a])	([a])	3.05	6.35	5.80	6.20	3.00	2.85	5.20	4.05	3.40	4.10
6	([a])	([a])	3.15	6.70	5.40	5.70	3.00	2.70	4.80	3.95	3.45	([a])
7	([a])	([a])	3.10	7.10	5.10	5.50	3.50	3.95	4.55	3.85	3.35	([a])
8	([a])	([a])	2.80	7.85	4.95	5.95	4.15	4.20	4.35	3.70	3.25	([a])
9	2.95	([a])	3.20	7.90	4.75	6.55	3.90	4.00	4.15	3.70	3.25	([a])
10	3.30	([a])	3.40	7.20	4.80	6.00	3.70	3.90	4.05	3.60	3.35	4.05
11	3.55	([a])	8.05	6.60	5.45	5.50	3.45	3.85	4.00	3.60	3.30	5.40
12	4.95	([a])	6.25	6.20	6.55	5.15	3.60	4.00	4.00	3.50	3.25	6.80
13	4.25	([a])	5.40	5.80	7.50	4.90	3.90	3.80	4.00	3.50	3.30	6.05
14	3.95	([a])	5.10	5.55	7.15	4.70	3.75	3.50	4.00	3.85	3.75	5.60
15	3.80	([a])	5.30	5.35	6.55	4.50	3.55	3.40	4.00	4.30	4.20	14.60
16	3.85	([a])	5.05	5.25	6.00	4.40	3.45	3.35	4.30	5.15	4.10	18.90
17	3.80	([a])	4.85	5.15	5.60	4.35	3.35	3.15	4.35	5.15	4.00	12.60
18	3.65	([a])	4.70	5.00	5.35	4.20	3.40	4.50	4.25	4.85	3.85	8.65
19	([a])	([a])	4.70	4.90	5.15	4.10	3.45	7.25	4.25	4.60	3.80	7.30
20	([a])	([a])	4.75	4.85	5.65	4.00	3.35	5.90	4.30	4.45	3.65	6.35
21	([a])	([a])	6.50	5.65	5.35	3.85	3.20	5.20	4.20	4.35	3.65	5.80
22	([a])	([a])	10.50	8.15	5.15	3.80	2.95	5.60	4.05	4.15	3.50	5.15
23	([a])	([a])	9.30	9.75	4.95	3.80	2.90	6.25	3.85	4.10	3.50	5.00
24	3.30	([a])	7.45	8.80	4.85	3.75	2.70	6.20	3.75	4.00	3.75	4.75
25	3.30	([a])	6.85	8.95	4.85	3.80	2.55	9.85	3.70	3.85	4.00	4.85
26	3.35	([a])	6.85	8.30	5.50	3.65	2.50	8.55	3.55	.....	4.00	4.80
27	3.35	([a])	8.10	7.75	5.95	3.50	2.50	6.75	3.50	3.85	4.30	5.45
28	3.20	([a])	9.40	6.90	5.75	3.50	2.55	6.00	3.45	3.75	4.10	5.05
29	3.25	.....	8.10	6.30	6.05	3.55	2.45	5.45	3.55	3.70	([a])	7.55
30	2.80	.....	6.70	5.90	8.30	3.45	3.80	5.00	4.40	3.60	([a])	9.20
31	2.70	.....	6.15	.....	9.60	.....	3.60	4.75	.....	3.60	.....	8.85

[a] River frozen at gage.

TOHICKON CREEK AT POINT PLEASANT, PA.

This station is described in Water-Supply Paper No. 47, page 81, where are also given tables of daily discharge in second-feet for the years 1883 to 1899, inclusive. Daily records of gage height were not kept during 1900. The following figures of discharge for 1901 were furnished by Mr. John E. Codman, hydrographer of the water department of the city of Philadelphia:

Daily discharge, in second-feet, of Tohickon River at Point Pleasant, Pa., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	23	11	9	81	87	289	5	6	508	11	7	22
2	31	10	11	77	74	237	5	4	60	19	7	19
3	35	9	26	812	136	248	4	4	42	38	5	87
4	31	10	55	795	131	231	4	4	29	52	11	153
5	31	7	129	268	68	145	4	4	34	40	14	150
6	31	4	129	276	58	97	4	4	25	25	9	131
7	27	6	71	535	58	97	4	11	27	21	6	109
8	20	7	71	307	53	102	4	15	16	16	4	81
9	17	10	60	136	49	81	4	20	11	11	5	187
10	40	11	158	98	480	41	4	17	16	9	5	215
11	1,359	8	3,353	75	844	15	4	11	19	9	4	125
12	1,768	8	858	65	1,219	13	4	9	25	10	7	213
13	371	9	254	44	351	11	5	12	35	7	8	178
14	138	9	605	31	184	9	5	9	37	12	7	165
15	97	11	743	40	183	8	6	7	29	18	7	2,843
16	76	11	358	57	158	8	6	7	27	31	9	1,803
17	64	9	202	57	111	6	6	5	21	31	8	758
18	44	9	140	51	73	18	6	893	17	18	6	330
19	23	9	131	52	38	23	5	565	17	18	9	220
20	23	9	131	283	13	10	5	205	16	14	10	184
21	27	9	2,119	1,203	8	7	5	63	16	13	10	158
22	27	9	800	667	7	5	5	278	10	17	10	131
23	27	9	239	266	11	6	5	336	7	15	10	131
24	27	9	205	1,107	17	7	4	627	9	10	123	131
25	27	9	246	3,388	28	5	3	387	11	7	201	131
26	31	9	306	636	49	3	3	95	11	10	101	371
27	24	9	620	239	178	4	4	83	10	10	57	806
28	15	9	956	166	351	5	5	71	10	6	61	567
29	14	.....	804	172	461	5	5	29	8	5	45	3,817
30	13	.....	367	140	433	4	6	23	7	7	34	4,089
31	12	.....	129	.....	336	.....	7	17	.....	7	.....	1,034
Mean	145	9	461	404	202	58	5	123	40	17	27	622

NESHAMINY CREEK, PENNSYLVANIA, BELOW THE FORKS.

This station, which was established in 1884, is described in Water-Supply Paper No. 47, page 90, where are also given figures of daily discharge for the years 1884 to 1900, inclusive. Results by months and a diagram of the daily discharge for 1900 are given on page 117 of the Twenty-second Annual Report, Part IV. The following table of daily discharge for 1901 was furnished by Mr. John E. Codman:

Daily discharge, in second-feet, of Neshaminy Creek, Pennsylvania, below the forks, for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	180	41	72	129	164	242	31	167	1,676	73	20	48
2	65	41	71	115	159	213	31	80	358	59	18	48
3	36	41	51	1,774	189	509	31	72	257	54	18	379
4	31	41	57	459	140	230	31	72	211	52	18	409
5	31	41	80	343	105	157	31	63	154	48	20	279
6	31	41	80	362	101	120	52	71	139	42	22	359
7	31	41	72	627	96	159	192	1,169	124	36	22	246
8	31	41	63	316	91	210	217	456	110	39	22	145
9	31	41	63	228	149	125	60	116	97	36	22	104
10	31	41	143	180	672	97	65	80	88	31	22	115
11	553	41	4,624	146	821	88	36	72	499	34	20	111
12	1,965	41	469	129	599	80	1,320	199	566	34	20	96
13	323	41	237	115	323	72	169	148	183	36	22	93
14	140	41	188	105	230	72	445	89	135	53	22	139
15	115	41	528	115	176	72	340	224	120	59	19	2,645
16	105	41	261	125	154	72	289	245	120	48	19	313
17	105	41	172	115	125	72	164	99	125	39	20	237
18	88	41	144	101	135	57	284	771	115	34	18	213
19	72	41	144	92	145	41	130	864	97	27	18	213
20	72	41	144	920	115	41	89	530	88	45	18	213
21	72	41	2,466	1,344	105	57	72	246	85	31	18	213
22	72	41	446	527	97	72	72	176	77	34	18	213
23	63	41	258	272	88	57	90	176	63	40	20	213
24	54	57	228	1,318	88	41	107	2,385	59	40	1,173	213
25	54	72	242	1,563	97	41	80	710	56	27	304	213
26	54	72	367	577	130	41	153	285	48	27	125	590
27	63	72	582	323	216	57	135	196	45	27	84	1,391
28	63	72	288	236	373	72	89	164	45	22	69	272
29	54	.....	195	194	620	108	222	142	60	27	76	2,796
30	54	.....	158	176	1,029	52	457	119	77	27	68	3,829
31	48	.....	143	.....	323	.....	157	125	.....	22	.....	667
Mean	151	46	421	434	253	111	182	331	196	39	78	549

PERKIOMEN CREEK AT FREDERICK, PA.

Measurements of this creek were begun on August 20, 1884. The station is described in Water-Supply Paper No. 47, page 98, and figures of monthly flow for 1900 are given on page 121 of the Twenty-second Annual Report, Part IV. The following record of daily discharge for 1901 was furnished by Mr. John E. Codman, hydrographer of the water department of the city of Philadelphia:

Daily discharge, in second-feet, of Perkiomen Creek at Frederick, Pa., for 1901.

Day	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	138	52	46	98	124	245	36	38	68	138	46	58
2	93	46	107	85	115	230	38	44	88	128	46	63
3	52	46	168	1,046	158	372	36	85	84	138	45	172
4	37	46	178	612	153	184	31	140	75	129	51	325
5	31	49	209	317	97	131	29	102	71	102	58	145
6	36	38	138	228	84	120	21	36	71	84	55	93
7	36	38	106	487	80	320	12	443	67	60	50	75
8	36	36	65	287	67	547	42	203	47	46	47	59
9	36	41	204	213	107	171	32	88	38	36	46	64
10	47	46	279	148	275	111	32	59	43	31	41	136
11	397	41	4,717	110	782	83	31	40	189	36	36	150
12	1,623	36	464	92	667	75	72	41	250	36	41	106
13	325	41	263	92	284	63	52	46	168	41	52	97
14	170	41	212	80	178	55	49	52	140	260	52	137
15	143	36	421	71	138	67	49	52	85	193	46	2,754
16	147	36	324	86	115	67	55	43	67	163	46	354
17	138	41	244	93	97	58	46	38	84	115	41	179
18	110	41	178	71	92	52	38	1,433	102	84	41	148
19	75	60	138	58	84	41	41	964	85	51	46	110
20	52	84	138	113	89	41	36	171	63	41	49	88
21	49	59	1,996	420	94	69	29	173	57	46	49	76
22	64	36	513	411	88	92	38	125	46	46	46	55
23	67	41	308	224	102	72	52	148	46	46	46	51
24	52	38	255	952	102	49	49	228	60	52	368	66
25	52	29	255	2,237	140	52	43	273	67	58	316	60
26	58	36	361	627	233	47	38	143	52	52	155	119
27	52	46	604	315	284	41	44	110	46	41	85	1,094
28	46	46	322	215	290	41	49	80	60	55	58	272
29	46	.....	217	178	711	36	43	71	122	60	55	6,017
30	41	.....	148	158	1,113	36	137	109	158	56	55	3,521
31	47	.....	106	.....	365	.....	78	120	.....	56	.....	625
Mean	139	44	441	337	236	119	44	184	87	80	72	557

WISSAHICKON CREEK NEAR PHILADELPHIA, PA.

This station is described in Water-Supply Paper No. 48, page 107, where also are given tables of daily discharge for the years 1897 to 1900, inclusive. Figures for the monthly flow for 1899 and diagrams of daily discharge for the period of observation, 1897 to 1899, inclusive, will be found in the Twenty-first Annual Report, Part IV, pages 81 and 82. Similar figures for 1900 will be found in the Twenty-second Annual Report, Part IV, page 124.

Daily discharge, in second-feet, of Wissahickon Creek near Philadelphia, Pa., for 1901.

Day.	Jan.	Feb.	Mar.	Aug.[a]	Sept.	Oct.	Nov.	Dec.
1	106	27	24	20	99	39	16	17
2	85	27	17	20	99	39	16	19
3	102	27	17	20	20	42	16	82
4	81	47	17	19	24	38	16	151
5	22	64	17	20	31	33	15	26
6	22	64	19	20	26	33	14	20
7	20	47	19	271	21	33	13	19
8	19	47	17	102	22	29	14	18
9	19	42	19	80	27	23	15	17
10	12	20	.....	42	26	29	14	18
11	18	20	.....	47	38	34	14	20
12	19	20	.....	31	43	34	14	20
13	224	26	.....	261	31	34	13	18
14	240	27	.....	261	31	47	13	18
15	68	22	.....	27	31	48	15	41
16	87	43	.....	22	30	29	15	59
17	80	64	.....	27	30	23	15	38
18	52	64	.....	355	27	27	14	22
19	31	64	.....	398	24	31	14	21
20	31	64	.....	244	28	31	14	23
21	31	64	.....	113	28	35	14	24
22	31	47	.....	81	27	42	15	22
23	31	26	.....	81	24	42	18	21
24	31	19	.....	1,095	27	31	515	20
25	31	16	.....	327	27	20	141	21
26	31	27	.....	131	23	17	62	81
27	31	30	.....	21	24	16	18	486
28	31	22	.....	21	24	16	18	77
29	31	.....	.....	37	24	17	16	1,265
30	27	.....	.....	43	32	16	16	1,188
31	22	.....	.....	27	.....	17	.....	250
Mean	54	38	[b] 18	138	32	30	37	133

[a] No record for April, May, June, and July.
[b] March 1 to 9, inclusive.

SCHUYLKILL RIVER ABOVE PHILADELPHIA, PA.

This river is described in Water-Supply Paper No. 48, page 109. Records of the height of the river at Fairmount dam have been kept for many years, but measurements for computing the daily discharge were not made until 1898. The first of the following tables does not represent the total flow of the stream, but the amount wasted over the flashboards at the dam, to which must be added the pumpage from the river, the leakage, and the quantity used for power at Fairmount. The second table is an estimate of the total monthly yield, in cubic feet, including the foregoing items. The figures were furnished by Mr. John E. Codman, hydrographer for the water department of the city of Philadelphia.

Daily discharge, in second-feet, of Schuylkill River above Philadelphia, Pa., for 1901, being amount wasted over flashboards at Fairmount dam.

Day.	Jan.	Mar.[a]	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1			1,459		3,358			1,421	929		
2			1,459		2,689			757	656		
3			3,503		2,991			953	1,057		
4			9,938		2,602			725	1,057		1,027
5			5,384		1,363			487	406		257
6			4,123		752			257	65		
7			4,885		1,149		1,676	183			
8			4,885		3,126	153	1,817	119			
9			4,347		1,964		168	119			
10			3,011	107	675			119			
11		25,744	2,321	1,562	369			953			1,907
12	5,738	11,368	1,981	4,913	155	1,636	3,666	2,945			2,054
13	2,581	4,879	1,981	2,764		518	449	1,502			1,188
14	870	3,666	1,661	1,562				668	153		1,188
15	229	3,666	1,661	562		51		167	1,061		16,079
16		2,075	1,661	238				65	646		24,025
17		1,414	1,359					65			9,714
18		1,079	822			506		65			4,747
19		834	586				15,022	330			2,293
20		397	586	559			10,359				511
21		5,123	675	130			4,204				264
22		12,536	616		158		1,903				
23		7,634	102		238		1,187				
24		4,813	636				3,976			1,651	
25		3,004	7,953				12,398			1,477	
26		2,963	2,824	674			11,147			119	
27		4,773	804	1,712			4,586				2,294
28		6,562	87	2,076			2,129				1,442
29		4,624		2,488	826		1,088				18,280
30		2,963		5,920	183		619	1,027			29,602
31		2,171		4,825		159	519				7,070

[a] No record for February.

Total monthly yield of Schuylkill River above Philadelphia, Pa., for 1901.

Month.	Yield.	Month.	Yield.
	Cubic feet.		*Cubic feet.*
January	3,725,819,000	July	3,528,988,000
February	1,568,578,000	August	9,794,065,000
March	13,064,328,000	September	2,509,553,000
April	9,566,355,000	October	4,065,475,000
May	7,806,038,000	November	2,596,137,000
June	6,341,078,000	December	14,753,129,000

NORTH BRANCH OF SUSQUEHANNA RIVER AT WILKESBARRE, PA.

This station, which was established by E. G. Paul on March 30, 1899, is described in Water-Supply Paper No. 48, page 110. The results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 125. During 1901 no measurements of discharge were made at this point.

Daily gage height, in feet, of North Branch of Susquehanna River at Wilkesbarre, Pa., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	10.60	8.60	6.20	9.70	7.80	14.55	4.50	3.40	5.80	3.90	3.20	7.30
2	10.60	8.40	6.10	8.80	7.20	11.70	4.00	3.20	5.60	3.70	3.20	6.70
3	9.50	8.30	6.10	8.30	8.70	11.00	3.50	3.00	5.70	4.00	3.10	6.80
4	8.70	8.40	6.10	9.30	8.90	10.60	3.60	3.00	5.30	4.30	3.10	[a]9.30
5	8.50	8.00	6.20	10.80	8.10	9.20	3.60	3.00	5.00	4.00	3.00	9.90
6	7.20	7.80	6.00	11.90	7.50	8.10	3.60	3.00	4.50	3.90	3.00	9.40
7	7.10	7.80	5.90	16.20	6.80	8.10	4.30	3.00	4.20	3.70	3.00	9.00
8	7.00	7.70	5.80	18.05	6.30	9.00	4.00	3.30	3.80	3.60	3.00	8.30
9	7.90	7.70	5.70	16.90	5.90	9.30	4.00	3.20	3.70	3.40	3.00	8.70
10	7.90	7.50	6.50	14.70	5.80	8.90	3.90	3.10	3.50	3.30	3.00	11.70
11	7.80	7.60	8.40	13.20	6.40	8.00	3.80	3.20	3.30	3.20	2.90	12.10
12	7.80	7.60	18.80	11.80	7.80	7.20	3.80	3.30	3.30	3.20	3.00	11.70
13	8.10	7.40	12.20	10.70	9.50	6.56	3.60	3.10	3.30	3.30	3.00	10.10
14	9.00	6.90	9.70	10.10	9.80	6.10	3.50	3.10	3.30	3.50	3.50	8.80
15	12.00	7.00	8.90	9.60	9.10	5.90	3.40	3.20	3.20	4.10	4.00	20.40
16	14.50	7.10	9.10	9.30	8.00	5.70	3.20	3.60	3.30	4.30	4.70	26.75
17	14.00	7.30	8.80	8.90	7.10	5.50	3.20	3.70	3.50	4.40	4.50	22.80
18	13.60	7.30	8.30	8.50	6.70	5.30	3.60	8.15	3.80	4.30	4.20	15.60
19	12.50	7.20	8.00	8.10	6.80	4.90	3.40	5.60	4.00	4.20	4.10	11.00
20	11.50	6.90	10.10	7.90	7.00	4.70	3.30	4.80	4.20	4.00	4.00	8.20
21	9.40	6.90	12.15	11.05	7.10	4.60	3.10	4.60	4.10	3.90	4.00	7.80
22	10.50	6.70	14.80	18.10	6.50	4.40	3.00	6.95	3.90	3.80	3.90	9.50
23	11.00	6.80	14.50	17.10	6.40	4.50	3.10	6.90	3.70	3.70	3.80	11.20
24	11.00	6.40	12.90	14.80	7.90	5.60	3.10	6.50	3.50	3.70	3.80	11.70
25	11.70	6.40	12.90	14.70	9.00	5.70	3.00	10.50	3.40	3.60	6.00	13.70
26	11.00	6.30	13.80	13.60	8.30	5.70	3.00	9.20	3.20	3.40	9.10	13.50
27	10.50	6.20	17.15	12.30	7.60	5.00	2.90	7.10	3.20	3.40	7.60	13.30
28	10.00	6.30	21.40	11.00	7.40	4.20	2.90	6.10	3.10	3.40	6.20	12.80
29	9.50	.....	19.45	9.60	10.60	4.50	3.00	5.30	3.30	3.20	5.50	13.10
30	9.30	.....	15.50	8.60	16.85	4.20	3.30	4.80	3.80	3.10	5.70	13.10
31	9.10	.....	12.90	.....	17.55	.....	3.60	4.90	.....	3.10	.....	13.50

[a] River frozen over.

NORTH BRANCH OF SUSQUEHANNA RIVER AT DANVILLE, PA.

This station, which was established March, 25, 1899, by E. G. Paul, is described in Water-Supply Paper No. 48, page 111. The results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 126. During 1901 measurements were made by Mr. Paul, as follows:

August 19: Gage height, 7.50 feet; discharge, 27,714 second-feet.
October 27: Gage height, 3.10 feet; discharge, 4,510 second-feet.

Daily gage height, in feet, of North Branch of Susquehanna River at Danville, Pa., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	5.70	(a)	(a)	8.50	6.65	13.60	3.70	3.30	4.60	3.50	2.90	4.10
2	8.60	(a)	(a)	7.65	6.10	9.05	3.70	3.00	5.10	3.50	2.90	3.90
3	(a)	(a)	(a)	7.20	6.50	9.65	3.40	2.70	4.90	3.85	2.80	3.90
4	(a)	(a)	(a)	7.60	7.60	9.15	3.20	2.60	4.90	4.05	2.80	4.55
5	(a)	(a)	(a)	8.65	7.35	8.30	3.10	2.60	4.30	3.85	2.80	5.95
6	(a)	(a)	(a)	9.40	6.65	7.50	3.10	2.60	4.25	3.70	2.70	7.90
7	(a)	(a)	(a)	8.60	6.05	6.80	3.10	2.70	3.95	3.50	2.70	(a)
8	(a)	(a)	(a)	8.55	5.35	7.30	3.60	2.90	3.70	3.30	2.60	(a)
9	(a)	(a)	(a)	7.80	5.30	7.60	3.50	3.10	3.50	3.20	2.60	(a)
10	(a)	(a)	(a)	7.45	6.50	7.55	3.40	2.90	3.35	3.20	2.60	9.55
11	(a)	(a)	(a)	7.10	5.00	7.00	3.30	3.50	3.25	3.10	2.60	9.80
12	(a)	(a)	12.00	6.75	5.70	6.40	3.30	3.30	3.10	3.00	2.60	10.05
13	(a)	(a)	11.15	6.50	6.60	5.60	3.20	3.00	3.00	2.90	2.80	8.90
14	(a)	(a)	8.50	8.60	7.95	5.20	3.10	2.90	3.05	3.90	2.90	7.90
15	(a)	(a)	7.60	8.15	7.85	5.00	3.00	2.80	3.00	3.85	3.00	14.65
16	(a)	(a)	7.30	7.80	7.05	4.95	2.90	2.80	3.10	3.90	3.45	22.57
17	(a)	(a)	7.40	7.45	6.30	4.60	2.90	2.80	3.10	3.90	3.90	20.05
18	(a)	(a)	6.90	7.10	5.80	4.60	3.00	6.60	3.40	3.90	3.90	13.85
19	(a)	(a)	6.60	6.75	5.80	4.45	3.10	7.85	3.50	3.80	3.60	10.25
20	(a)	(a)	6.60	6.50	5.70	4.10	3.00	5.60	3.50	3.90	3.50	8.30
21	(a)	(a)	9.25	6.90	5.95	4.00	2.90	4.55	3.60	3.60	3.50	7.10
22	(a)	(a)	11.85	12.60	5.75	3.90	2.80	4.75	3.60	3.50	3.50	5.90
23	(a)	(a)	12.70	15.25	5.35	3.90	2.70	6.30	3.40	3.40	3.40	5.10
24	(a)	(a)	11.35	12.75	5.40	4.25	2.60	8.10	3.40	3.30	3.40	4.90
25	(a)	(a)	11.25	12.05	6.55	5.35	2.60	11.02	3.10	3.30	3.70	4.75
26	(a)	(a)	11.15	11.70	7.40	4.70	2.60	9.25	3.00	3.20	6.17	4.95
27	(a)	(a)	13.35	10.65	6.90	4.45	2.60	7.55	2.90	3.10	7.00	5.10
28	(a)	(a)	17.00	8.90	6.40	4.10	2.60	6.15	2.80	3.10	5.85	5.00
29	(a)	.....	16.85	8.25	8.00	3.85	2.50	5.35	2.90	3.00	4.95	5.20
30	(a)	.....	13.35	7.35	12.70	3.80	2.70	4.70	3.20	3.00	4.35	7.15
31	(a)	.....	10.45	.....	14.95	.....	2.90	4.40	.....	2.90	.....	6.80

[a] Ice.

WEST BRANCH OF SUSQUEHANNA RIVER AT WILLIAMSPORT, PA.

Observations of water height on the West Branch have been made for several years from the Market street bridge. A bench mark and datum for observation gage were established March 1, 1895, under the direction of Mr. George D. Snyder, city engineer, who has since that time had daily gage height read and has supplied this office with copy, which is published herewith. A discharge measurement was made August 16, 1901, and a wire gage erected on the upper side of Market street bridge for more conveniently making daily readings. The length of the wire from the extreme end of the weight to the marker is 40.29 feet. The distance from the center of the gage pulley to the surface of the water is 38.66 feet when the gage reads 0.66 foot.

A bench mark cut in the face of the left bank abutment is 10 feet above datum of the gage. The following discharge measurements were made during 1901 by E. G. Paul

August 16. Gage height, 0.90 foot. discharge, 1,932 second-feet.
October 25. Gage height, 0.66 foot discharge, 1,807 second-feet.

Daily gage height, in feet, of West Branch of Susquehanna River at Williamsport, Pa., for 1895.

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	8.0	6.0	2.1	2.4	4.5	0.3	0.4	0.1	−0.1	1.5
2	9.0	6.0	1.9	2.1	3.7	0.2	0.4	0.1	−0.1	1.6
3	10.5	7.2	1.9	1.9	3.0	0.2	0.3	0.2	0.0	1.5
4	9.5	6.5	1.9	1.8	2.3	0.1	0.3	0.3	0.0	1.4
5	9.0	5.8	1.8	1.5	1.7	0.1	0.2	0.3	−0.1	1.4
6	6.5	5.4	1.8	1.5	1.5	0.0	0.2	0.2	−0.1	1.3
7	4.5	6.0	1.6	1.4	1.5	0.0	0.1	0.1	0.0	1.0
8	4.5	7.0	2.2	1.2	1.3	0.3	0.0	0.2	+0.1	1.1
9	5.0	11.0	2.9	0.8	1.2	0.3	0.0	0.2	0.1	1.1
10	5.2	12.0	3.2	0.5	1.6	0.3	0.3	0.1	0.3	1.0
11	5.3	11.0	2.8	0.4	1.5	0.4	1.6	0.1	0.3	1.0
12	5.5	7.9	2.7	0.2	1.5	0.7	1.8	0.2	0.4	0.9
13	5.5	6.5	2.8	0.2	1.6	1.8	0.9	0.2	0.4	0.8
14	5.2	8.0	4.3	0.4	1.5	1.5	0.7	0.2	0.3	0.6
15	6.0	10.5	3.8	0.8	1.4	0.5	0.5	0.2	0.3	0.4
16	6.5	8.5	3.3	0.8	1.3	0.6	0.4	0.3	0.2	0.3
17	5.5	6.0	3.0	0.7	1.2	0.7	0.6	0.2	0.2	0.3
18	5.0	5.3	2.8	0.7	1.1	0.9	0.1	0.2	0.2	0.3
19	4.7	5.3	2.6	0.6	1.0	1.1	0.2	0.2	0.2	0.2
20	4.5	5.3	2.8	0.6	0.8	1.1	0.2	0.2	0.3	0.2
21	4.2	4.5	2.2	0.6	0.7	1.1	0.1	0.2	0.3	0.2
22	4.5	3.6	2.0	0.4	0.9	1.2	0.0	0.2	0.3	1.6
23	5.0	3.4	1.9	1.0	0.8	1.3	−0.1	0.2	0.2	2.4
24	5.5	3.2	1.8	1.4	0.8	1.4	−0.2	0.1	0.2	2.6
25	6.0	2.9	1.7	1.7	0.9	1.4	−0.2	0.0	0.4	2.4
26	8.7	2.6	1.7	1.3	1.0	1.5	−0.2	−0.1	0.5	2.2
27	9.2	2.6	2.0	1.7	−0.2	1.3	−0.1	−0.1	2.9	2.4
28	7.7	2.5	3.5	6.2	0.0	1.3	−0.1	−0.1	3.1	7.0
29	6.7	2.5	3.6	4.9	+0.1	1.3	0.0	−0.1	2.3	6.5
30	6.5	2.2	3.2	4.0	0.1	1.4	+0.2	−0.1	2.1	4.5
31	6.3	.....	3.0	.....	0.4	1.4	.....	−0.2	.....	5.4

Daily gage height, in feet, of West Branch of Susquehanna River at Williamsport, Pa., for 1896.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	6.8	1.9	6.5	13.0	3.5	1.8	3.1	6.5	0.5	6.8	2.3	4.0
2	4.5	2.0	6.6	11.0	3.4	2.0	2.7	6.7	0.4	6.8	2.3	3.8
3	4.1	2.4	6.1	10.0	3.1	1.7	2.3	6.9	0.4	5.8	2.3	3.3
4	3.8	4.1	4.7	8.5	3.0	1.4	2.0	5.9	0.4	4.5	2.1	3.1
5	3.5	4.1	3.9	7.1	2.8	1.3	2.3	4.8	0.4	3.2	2.5	2.9
6	3.3	3.9	4.1	6.1	2.6	1.2	2.4	4.0	0.5	1.7	7.5	2.4
7	3.1	10.8	4.0	5.8	2.4	1.4	2.3	3.5	0.5	1.5	6.9	2.0
8	2.9	9.2	3.9	5.6	2.3	1.6	2.1	3.7	0.6	1.3	6.2	1.7
9	2.4	6.8	3.9	5.1	2.2	2.6	2.0	3.2	0.7	0.9	5.4	3.2
10	2.4	6.1	3.8	4.7	2.1	5.3	3.3	2.9	0.6	0.9	4.5	4.4
11	2.3	5.3	3.6	4.8	1.9	4.3	3.0	2.7	0.4	0.8	4.3	5.0
12	2.1	4.3	3.1	5.3	1.9	3.4	2.6	2.5	0.4	0.7	3.9	4.2
13	2.0	4.1	2.4	5.7	1.6	2.9	2.2	2.2	0.4	9.8	4.0	4.0
14	2.0	3.7	2.7	7.8	1.6	2.5	1.9	2.5	0.4	10.8	4.0	3.5
15	1.8	3.7	2.4	8.3	1.5	2.2	1.7	2.3	0.5	9.8	3.6	3.3
16	1.7	4.6	2.0	7.5	1.5	2.2	1.8	2.1	0.6	8.2	3.1	3.2
17	1.5	4.3	2.4	6.8	1.5	2.1	1.9	1.8	0.6	6.5	3.1	2.9
18	1.4	3.6	2.5	6.1	1.6	4.1	2.2	1.5	0.9	6.1	3.0	2.9
19	1.3	3.2	2.4	5.7	1.4	4.6	2.3	1.4	0.6	5.4	2.8	2.7
20	1.3	1.7	3.6	5.2	1.3	3.5	1.8	1.2	1.5	4.7	2.7	2.5
21	1.4	1.5	3.8	4.7	1.4	3.0	1.6	1.0	2.0	4.0	2.7	2.2
22	1.4	2.2	3.8	4.7	1.3	2.6	1.7	0.9	1.6	3.7	2.7	2.2
23	1.4	1.9	4.5	4.5	1.3	2.4	1.8	0.9	0.7	3.6	2.6	2.1
24	1.6	2.3	4.2	4.4	1.1	2.1	2.0	0.8	0.6	3.5	2.6	2.4
25	2.5	3.2	4.1	4.1	1.0	3.5	2.5	1.0	0.3	3.4	2.8	2.2
26	2.7	3.1	4.2	4.2	1.1	7.0	3.1	1.0	0.3	3.3	2.8	2.0
27	2.9	2.3	4.8	4.1	1.1	6.2	3.8	0.9	0.4	3.2	2.8	1.8
28	2.9	2.6	5.6	3.8	1.2	5.1	3.9	0.6	0.5	3.0	2.8	1.5
29	2.5	4.0	7.1	3.7	1.2	4.4	5.0	0.6	0.6	2.7	3.3	1.3
30	2.2	.....	10.8	3.7	1.0	3.8	5.8	0.6	1.3	2.5	4.0	1.6
31	2.0	.....	13.9	.....	1.5	.....	6.8	0.5	.....	2.5	.....	1.8

Daily gage height, in feet, of West Branch of Susquehanna River at Williamsport, Pa., for 1897.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.9	1.6	4.0	4.3	2.6	1.9	1.0	3.1	0.7	0.9	0.4	4.4
2	2.0	1.5	3.5	4.0	3.9	1.8	1.0	3.0	0.7	0.9	1.0	3.8
3	2.1	1.5	3.1	3.7	5.2	1.8	1.0	2.5	0.6	0.8	4.8	3.4
4	2.1	1.5	5.1	3.4	8.8	2.4	0.9	2.2	0.6	0.7	4.1	3.1
5	2.8	1.5	7.0	3.2	8.5	2.3	0.9	2.1	0.5	0.6	3.1	4.0
6	3.9	1.5	7.4	3.3	7.9	2.0	0.7	2.0	0.4	0.5	2.7	4.5
7	3.5	3.7	10.4	3.6	7.2	1.7	0.7	2.4	0.3	0.5	2.3	5.0
8	3.0	4.1	9.1	3.8	6.1	1.6	0.7	2.2	0.3	0.4	1.9	4.7
9	3.0	3.9	7.6	4.0	5.5	1.6	0.7	2.1	0.2	0.3	1.8	4.1
10	3.0	3.7	6.9	8.0	4.9	1.8	0.8	1.7	0.2	0.3	2.0	3.8
11	3.0	3.5	7.8	8.8	4.6	1.8	0.8	1.6	0.0	0.3	2.1	3.6
12	3.2	3.6	8.6	7.8	4.5	1.7	1.0	2.0	0.0	0.3	2.9	3.8
13	2.9	3.3	8.8	6.7	4.4	1.5	0.9	1.9	0.1	0.4	2.6	4.0
14	1.8	3.0	8.6	5.9	6.5	1.4	0.9	1.7	0.1	0.5	2.4	4.1
15	1.7	2.7	7.7	5.6	7.4	1.3	0.9	1.5	0.1	0.5	2.2	4.8
16	2.2	2.7	6.7	6.6	7.1	1.2	1.0	1.3	0.2	0.5	2.1	7.4
17	2.2	2.7	6.1	7.8	6.9	1.1	1.0	1.1	0.3	0.4	2.3	7.7
18	2.2	2.8	5.1	6.9	5.4	1.1	1.1	1.0	0.4	0.3	4.9	6.7
19	2.5	3.6	5.3	6.1	4.8	1.1	1.1	0.8	0.5	0.3	4.5	6.3
20	2.2	3.6	5.4	5.4	4.8	1.3	1.1	1.0	0.5	0.3	3.8	5.9
21	1.4	3.7	8.3	4.9	4.6	1.5	1.1	1.1	0.5	0.4	3.4	5.3
22	1.6	3.9	8.8	4.4	4.4	1.2	1.2	1.0	0.6	0.5	3.0	4.9
23	2.0	5.1	8.5	4.0	3.8	1.1	1.2	0.9	0.7	0.6	2.7	4.6
24	2.2	8.8	8.8	3.7	3.2	1.1	2.0	3.5	0.8	0.7	2.5	3.8
25	2.4	7.8	11.3	3.4	3.0	1.1	2.3	2.8	2.4	0.6	2.3	3.6
26	2.2	6.3	10.2	3.1	2.8	1.2	2.5	2.2	2.3	0.6	2.0	3.3
27	2.3	5.2	8.4	3.1	2.7	1.2	2.0	1.5	2.2	0.6	2.5	3.0
28	1.5	4.3	7.1	3.0	2.6	1.2	3.1	1.2	2.0	0.5	3.5	3.1
29	1.8	.....	6.2	2.9	2.4	1.2	4.6	1.0	1.7	0.5	5.7	2.4
30	1.9	.....	5.3	2.7	2.2	1.0	4.8	0.8	1.1	0.4	5.0	2.0
31	1.8	.....	4.7	.....	2.0	.....	3.8	0.8	.....	0.4	.....	2.2

Daily gage height, in feet, of West Branch of Susquehanna River at Williamsport, Pa., for 1898.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.0	2.9	3.5	8.2	4.6	3.5	2.0	1.0	1.1	0.6	3.3	1.8
2	1.9	2.6	3.2	6.9	4.1	3.1	1.6	.9	1.0	.5	3.0	1.9
3	1.7	2.5	3.2	6.1	4.0	2.8	1.4	1.0	.9	.5	2.7	1.9
4	1.7	2.1	3.1	5.3	3.8	2.5	1.3	1.3	.9	.5	2.4	2.1
5	1.8	2.8	3.0	4.8	3.4	2.2	1.1	2.8	.8	.6	2.2	2.3
6	2.0	2.9	2.9	4.4	3.5	2.0	1.0	2.9	.8	1.1	2.0	2.6
7	2.1	3.1	2.8	4.0	3.8	1.8	.9	2.0	.7	1.0	2.0	2.6
8	2.1	3.0	3.0	3.7	3.8	1.8	.8	1.5	.7	1.3	1.8	2.5
9	2.1	2.9	3.1	3.5	3.9	1.6	.8	1.3	.9	1.2	1.8	2.2
10	2.1	2.9	3.8	3.3	4.1	1.4	.8	1.2	1.0	1.2	1.8	2.0
11	2.5	3.1	4.7	3.2	3.7	1.6	.7	1.1	.8	1.1	4.8	1.8
12	2.6	3.8	6.3	3.0	3.4	1.8	.7	1.0	.6	1.1	9.4	1.6
13	2.9	8.4	9.0	2.9	3.2	2.0	.7	1.0	.7	1.2	7.3	1.8
14	9.6	8.0	9.4	2.7	3.0	2.5	.6	1.7	.6	1.3	6.3	1.6
15	8.7	7.1	9.4	2.7	3.0	3.4	.6	1.4	.6	1.5	5.3	1.5
16	7.5	6.3	7.2	3.5	2.9	3.1	.6	1.2	.6	1.4	4.9	1.4
17	8.2	4.7	6.2	3.5	3.0	2.5	.5	1.0	.5	1.3	4.1	1.3
18	7.2	4.6	5.8	3.5	3.0	2.0	.5	1.0	.5	1.2	3.6	1.4
19	6.1	4.3	5.4	3.2	4.0	1.9	.5	1.4	.4	1.3	3.4	1.5
20	5.3	4.8	9.0	3.1	3.9	1.8	.5	6.8	.5	2.3	3.2	1.7
21	5.6	5.3	10.8	3.0	5.1	1.7	.7	4.8	.4	2.7	3.0	2.0
22	6.2	6.4	10.2	3.0	4.8	1.6	.8	3.9	.5	4.2	2.8	2.6
23	7.0	6.0	14.9	2.9	5.1	1.6	.8	3.0	.4	9.0	2.7	5.3
24	9.9	5.3	21.0	4.0	5.1	1.4	.7	2.5	.4	8.9	2.6	8.3
25	9.3	5.0	14.8	7.7	6.0	1.3	.7	2.1	.4	7.0	2.4	7.3
26	7.6	4.6	10.4	8.7	6.3	1.2	.7	2.1	.5	5.0	2.3	6.3
27	6.8	4.2	9.6	8.2	5.6	1.1	1.9	1.9	.5	4.7	2.1	5.3
28	6.0	3.8	7.1	6.4	5.3	1.0	1.9	1.8	.6	5.0	1.9	4.7
29	5.3	.....	6.3	5.7	4.8	2.1	1.3	1.7	.5	4.7	1.8	4.3
30	4.7	.....	9.9	5.1	4.3	2.7	1.0	1.6	.6	4.2	1.8	4.1
31	4.1	.....	10.1	.....	3.9	.....	1.0	1.5	.....	3.6	.....	3.9

Daily gage height, in feet, of West Branch of Susquehanna River at Williamsport, Pa., for 1899.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.9	3.0	7.8	6.8	2.9	2.4	1.2	0.4	1.4	0.4	0.4	1.5
2	3.9	2.8	7.3	6.4	2.8	2.4	1.1	.3	1.5	.5	3.8	1.5
3	3.9	2.6	7.3	6.0	2.7	2.3	1.0	.3	1.5	.5	3.8	1.6
4	3.8	2.5	7.8	5.3	2.7	2.2	.9	.1	1.5	.4	3.8	1.6
5	4.8	2.6	11.8	4.5	2.9	2.1	.8	.2	1.5	.4	3.4	1.9
6	7.0	2.8	13.1	4.3	2.5	1.9	.7	.1	1.4	.4	2.9	1.6
7	8.0	2.8	11.3	4.3	2.3	1.7	.7	.0	1.3	.4	2.4	1.5
8	6.3	2.9	9.1	6.8	2.2	1.5	.7	.0	1.3	.4	2.1	1.7
9	5.3	2.9	7.3	7.8	2.3	1.3	.6	.1	1.2	.4	1.9	1.6
10	4.3	2.8	6.3	7.8	2.4	1.3	.6	.1	1.2	.4	2.0	1.7
11	4.0	2.7	5.4	6.8	2.4	1.2	.6	.2	1.1	.4	2.1	1.7
12	3.9	2.6	6.3	6.3	2.7	1.2	.6	.2	1.0	.4	2.2	1.9
13	3.8	2.4	7.3	6.8	2.5	1.1	.6	.8	.9	.4	2.3	7.0
14	4.3	2.3	7.8	7.3	2.4	1.0	.6	.6	.8	.3	2.6	7.5
15	4.8	2.3	7.1	7.3	2.3	1.0	.6	.4	.7	.3	2.9	6.3
16	5.3	2.4	6.1	6.8	2.2	1.0	.6	.2	.7	.3	3.1	5.5
17	5.8	2.5	5.8	6.3	2.0	.9	.6	.3	.6	.3	3.2	4.7
18	5.8	2.6	5.8	5.1	2.7	.9	.8	.3	.5	.3	3.6	4.0
19	5.6	2.8	7.5	4.9	6.8	.8	1.1	.2	.5	.3	3.5	3.9
20	4.5	3.2	9.3	4.6	7.3	.8	1.4	.1	.4	.3	3.5	3.8
21	3.9	3.3	8.8	4.4	6.1	.7	1.7	.0	.4	.3	3.2	4.3
22	3.9	4.2	7.6	4.2	4.9	.5	1.2	.2	.3	.3	2.9	4.9
23	3.8	5.3	6.8	4.0	4.1	.6	1.0	.1	.3	.3	2.6	4.3
24	3.8	6.8	7.0	3.7	3.6	.5	.8	.1	.4	.3	2.4	4.5
25	4.0	7.3	5.8	3.5	3.1	1.3	.7	.1	.3	.3	2.3	4.8
26	4.2	6.3	5.8	3.3	2.9	1.0	.6	.2	.3	.2	2.2	5.0
27	3.6	5.3	5.8	3.7	2.7	1.3	.6	1.4	.3	.2	2.1	4.5
28	3.5	8.3	5.6	3.6	2.5	1.2	.4	2.5	.3	.2	1.9	4.3
29	3.4	.....	6.5	3.3	2.4	1.3	.3	2.0	.4	.2	1.9	3.8
30	3.2	.....	8.3	3.1	2.4	1.3	.4	1.7	.4	.1	1.7	3.7
31	3.0	.....	7.8	.....	2.5	.....	.4	1.5	.....	.1	.....	3.5

Daily gage height, in feet, of West Branch of Susquehanna River at Williamsport, Pa., for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.3	2.9	4.0	3.9	3.3	3.3	1.3	0.6	0.8	0.1	1.0	5.8
2	3.2	2.8	9.0	3.8	3.1	2.9	1.5	.6	.7	.1	1.0	5.0
3	3.1	2.8	8.2	4.2	2.9	3.2	1.3	.6	.6	.1	.9	4.8
4	3.0	2.9	7.1	4.5	2.7	3.5	1.0	.5	.5	.2	.9	4.3
5	2.9	2.9	6.0	4.8	2.6	3.5	.9	.5	.5	.2	.9	6.8
6	2.8	3.3	5.2	4.5	2.5	3.0	1.0	.4	.4	.2	.9	7.2
7	2.6	3.0	5.3	5.0	2.3	2.7	1.1	.4	.3	.2	.8	5.8
8	2.5	3.0	7.1	6.5	2.2	2.5	1.1	.3	.3	.3	.8	5.7
9	2.6	4.5	6.5	6.8	2.0	2.4	1.0	.3	.3	.4	.8	4.8
10	2.6	6.0	6.2	6.1	2.0	2.2	.9	.2	.3	.9	.8	4.5
11	2.6	5.5	7.0	5.5	2.0	2.0	1.0	.2	.3	1.1	.8	4.2
12	2.7	5.0	6.3	4.8	2.0	1.9	1.1	.1	.2	1.0	.9	3.5
13	2.8	5.0	5.1	4.5	2.0	1.8	1.0	.1	.2	1.0	.9	3.0
14	2.9	8.7	4.5	4.3	2.0	1.6	1.7	.2	.2	1.0	.9	2.9
15	3.0	8.5	4.1	4.1	2.3	1.7	1.3	.1	.2	.9	.9	2.8
16	3.0	6.5	3.5	3.9	2.3	1.9	1.1	.1	.1	1.1	.8	2.3
17	3.0	5.5	2.8	3.9	2.0	1.7	.9	.2	.1	1.2	.8	1.9
18	3.3	4.7	2.7	5.1	2.0	1.6	.8	.2	.2	1.1	.7	1.8
19	3.8	3.8	2.5	6.9	2.0	1.5	.8	.2	.2	.9	.7	2.1
20	4.5	3.6	3.1	6.8	2.5	1.4	.7	.2	.2	.8	.7	2.0
21	13.0	3.5	7.0	6.2	2.5	1.3	.7	.3	.2	.7	.8	2.0
22	13.0	5.5	6.1	5.5	2.3	1.2	.6	.7	.2	.7	1.0	1.9
23	10.0	9.8	5.0	5.5	2.0	1.2	.6	1.0	.1	.7	1.4	1.9
24	8.0	7.4	5.5	5.9	1.8	1.1	.6	.9	.1	.7	1.5	1.8
25	6.5	5.4	6.0	5.7	1.7	1.0	.6	.9	.1	.9	2.7	1.9
26	5.8	5.2	5.2	5.2	1.8	1.1	.5	.9	.1	1.8	4.8	2.1
27	5.0	3.2	4.9	4.7	2.0	1.0	.7	1.0	.1	1.5	17.0	2.4
28	4.5	3.9	4.5	4.2	1.9	0.9	1.0	.9	.1	1.4	12.0	2.3
29	4.0	.....	4.5	3.8	1.9	0.8	.9	1.0	.1	1.3	8.0	2.3
30	4.1	.....	4.4	3.6	4.0	0.8	.8	1.0	.1	1.1	5.5	2.3
31	3.3	.....	4.1	.....	3.6	.....	.7	.9	.....	1.1	.....	2.2

Daily gage height, in feet, of West Branch of Susquehanna River, at Williamsport, Pa., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	Juiy.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.30	1.60	0.90	5.50	4.00	9.80	3.10	1.20	3.00	1.80	0.70	3.00
2	2.30	1.40	1.00	4.80	3.80	7.20	2.60	1.10	3.50	1.50	.60	2.80
3	1.90	1.40	1.30	4.50	4.00	7.00	2.30	1.00	6.80	2.00	.60	3.00
4	1.10	1.40	1.40	6.00	4.60	6.50	2.20	.80	5.70	1.50	.70	2.60
5	1.00	1.60	2.10	6.20	4.20	5.70	2.10	.70	4.60	1.40	.60	2.30
6	1.00	1.80	3.00	7.00	4.00	5.10	2.00	.70	4.10	1.30	.60	2.00
7	1.10	2.50	3.70	9.50	3.70	5.00	1.90	.80	3.30	1.20	.60	1.80
8	1.10	1.90	3.00	11.50	3.50	5.50	1.80	1.80	2.70	.90	.60	1.80
9	1.40	1.40	2.60	11.20	3.10	5.30	1.60	1.90	2.40	.80	.50	1.80
10	1.50	1.30	3.00	9.50	3.30	5.00	1.50	1.70	2.20	.90	.50	2.80
11	1.80	1.30	7.00	8.20	3.40	4.50	1.40	1.50	2.00	.90	.40	6.90
12	2.10	1.90	10.50	7.20	3.40	4.10	1.30	1.40	2.00	.90	.50	6.10
13	3.60	2.40	9.20	6.20	3.40	3.90	1.10	1.10	2.00	1.00	.60	5.50
14	4.50	2.10	7.50	5.80	3.60	3.30	1.10	.90	2.30	1.30	.60	5.20
15	4.20	1.50	6.50	5.50	3.60	3.00	1.10	.80	2.50	1.10	1.50	20.17
16	4.00	1.40	6.80	5.30	3.50	3.60	1.00	.90	2.80	.80	1.20	18.20
17	3.70	1.30	6.00	4.80	3.30	3.40	1.00	3.30	2.70	1.10	1.30	12.00
18	3.50	1.20	5.50	4.20	3.50	2.90	1.20	3.30	3.00	1.00	1.50	8.80
19	2.90	1.20	5.00	4.20	3.40	2.70	1.20	4.50	3.00	.90	1.30	7.00
20	2.40	1.30	6.20	4.00	3.20	2.60	1.10	4.20	2.80	.80	1.10	5.50
21	2.00	1.40	7.50	12.00	3.00	2.90	1.00	4.00	2.50	.80	1.00	5.00
22	1.90	1.30	9.50	15.20	1.80	4.00	.90	4.60	2.30	.70	.90	4.40
23	2.20	1.20	8.50	12.50	5.80	4.50	.70	4.00	2.00	.60	.80	3.70
24	2.60	1.00	7.50	9.70	5.50	4.40	.70	5.40	1.90	.60	1.60	3.60
25	2.40	.90	6.50	8.50	5.50	4.20	.70	7.80	1.80	.60	5.60	3.60
26	2.50	.90	7.80	7.50	5.00	3.80	.80	6.80	1.50	.60	6.70	3.70
27	2.60	1.00	10.50	6.50	5.00	3.50	.90	5.20	1.40	.60	5.70	3.90
28	2.60	1.00	11.20	5.50	7.60	3.60	1.00	4.30	1.20	.60	4.40	3.40
29	2.70	.....	9.20	5.00	11.50	3.70	1.10	3.50	1.50	.70	3.60	3.20
30	2.60	.....	7.80	4.50	14.00	3.50	1.20	3.00	1.90	.80	3.50	3.00
31	1.70	.....	6.20	.....	12.30	.....	1.20	2.70	.....	.70	.....	3.40

WEST BRANCH OF SUSQUEHANNA RIVER AT ALLENWOOD, PA.

This station, which was established by E. G. Paul, March 23, 1899, is described in Water-Supply Paper No. 48, page 111. The results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 127. During 1901 measurements of discharge were made by Mr. Paul, as follows:

August 17: Gage height, 4.10 feet; discharge, 8,857 second-feet.
October 26: Gage height, 2.30 feet; discharge, 2,308 second-feet.

Daily gage height, in feet, of West Branch of Susquehanna River at Allenwood, Pa., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.00	2.50	3.00	5.80	4.70	8.50	2.90	2.50	4.10	3.30	2.40	4.00
2	3.00	2.50	3.00	5.60	4.60	7.70	2.90	2.40	4.20	3.20	2.60	3.90
3	3.00	2.50	2.90	5.20	5.00	7.20	2.80	2.40	4.20	3.10	2.80	3.70
4	3.00	2.50	3.00	6.50	5.20	6.70	2.80	2.30	4.30	3.10	3.00	3.60
5	3.00	2.60	3.50	6.80	5.00	5.70	2.80	2.20	4.40	3.00	3.10	3.40
6	2.80	2.80	4.80	7.00	4.90	5.00	2.70	2.20	4.40	3.10	3.10	3.40
7	2.70	3.00	5.20	9.15	4.70	5.70	2.70	2.30	4.20	3.20	2.20	3.20
8	2.50	2.50	5.50	10.00	4.60	5.90	2.70	2.50	4.10	3.30	2.40	5.00
9	2.50	3.00	5.80	11.15	4.40	6.00	2.70	3.10	3.90	3.40	2.40	7.20
10	2.90	3.50	4.80	9.30	4.00	5.90	2.70	3.00	3.90	3.40	3.40	6.50
11	3.40	4.00	9.50	8.30	4.20	5.60	2.70	2.90	3.80	3.60	3.60	6.20
12	3.80	4.00	9.70	7.00	4.30	5.20	2.60	2.80	3.80	3.60	3.40	6.20
13	4.50	3.80	9.10	6.80	4.30	5.00	2.60	2.80	3.80	3.70	3.30	5.90
14	4.90	4.20	8.50	6.40	4.40	4.90	2.50	2.70	3.80	3.40	3.20	8.00
15	4.50	4.00	7.40	6.30	4.50	4.80	2.50	2.70	3.60	3.20	3.20	20.15
16	4.20	3.80	6.80	5.80	4.50	4.40	2.50	2.60	3.70	3.00	3.10	17.70
17	4.00	3.50	6.20	5.40	4.70	4.30	2.40	4.10	3.80	2.90	3.10	11.30
18	4.00	3.20	5.80	5.20	4.60	4.10	2.40	4.30	3.90	2.80	3.00	7.40
19	3.90	3.00	7.20	5.10	4.80	4.00	2.20	4.50	3.80	2.70	3.00	7.00
20	3.50	3.00	8.00	6.30	4.40	4.00	2.20	4.70	3.60	2.50	2.90	5.90
21	3.20	3.20	8.00	11.40	4.20	3.90	2.10	4.60	3.50	2.40	2.80	5.40
22	3.00	3.00	8.00	14.30	4.20	3.80	2.10	6.40	3.50	2.30	2.60	5.10
23	3.00	3.90	8.00	11.60	5.20	3.70	2.00	7.90	3.30	2.30	2.40	4.80
24	2.80	3.00	7.60	10.20	6.20	3.50	2.00	7.70	3.30	2.30	5.00	4.50
25	2.50	3.00	7.20	9.30	5.80	3.30	2.00	6.80	3.20	2.30	6.70	4.40
26	2.50	3.00	9.40	8.50	6.00	3.30	2.00	6.20	3.20	2.30	5.90	4.30
27	2.50	3.00	11.20	7.40	6.40	3.10	2.20	5.70	3.00	2.30	5.50	4.20
28	2.50	3.00	11.20	5.80	7.10	3.10	2.20	4.80	2.80	2.20	4.80	4.10
29	2.50	.....	8.70	5.30	11.15	2.90	2.40	4.30	2.70	2.10	4.00	4.10
30	2.50	.....	7.00	5.00	13.00	2.90	2.50	4.20	2.80	2.20	4.20	4.00
31	2.50	.....	6.60	.....	10.40	.....	2.50	4.10	.....	2.30	.....	3.90

JUNIATA RIVER AT NEWPORT, PA.

This station, which was established March 21, 1899, by E. G. Paul, is described in Water-Supply Paper No. 48, page 112. The results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 128. During 1901 measurements of discharge were made by Mr. Paul, as follows:

August 14: Gage height, 3.40 feet; discharge, 1,915 second-feet.
October 24: Gage height, 3.10 feet; discharge, 1,288 second-feet.

Daily gage height, in feet, of Juniata River at Newport, Pa., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.40	3.40	3.50	5.10	4.80	8.80	4.10	3.50	5.40	3.00	3.00	3.60
2	3.30	3.30	3.50	4.90	4.70	7.70	4.20	3.50	5.40	3.40	3.00	3.50
3	3.30	3.30	3.60	4.90	4.50	7.10	4.20	3.50	5.20	3.50	3.00	4.20
4	3.10	3.40	3.60	7.60	4.60	6.10	(a)	3.30	5.00	3.50	3.00	4.20
5	3.30	3.80	4.40	9.00	4.50	5.20	(a)	3.10	4.60	3.50	3.00	4.20
6	3.40	4.30	4.80	10.50	4.40	5.00	(a)	3.10	4.20	3.40	3.00	4.20
7	3.20	4.30	4.70	11.00	4.20	4.90	(a)	4.50	4.00	3.30	3.00	4.20
8	3.60	4.30	4.40	10.90	4.10	5.30	(a)	6.20	3.90	3.20	3.00	3.70
9	3.30	4.30	4.20	9.50	4.00	5.10	(a)	5.00	3.70	3.20	3.00	4.20
10	3.20	4.30	5.00	7.90	4.20	4.60	(a)	4.10	3.60	3.10	3.00	5.50
11	3.20	4.00	15.90	7.00	4.70	4.50	3.30	4.00	3.70	3.10	3.00	7.00
12	3.50	3.80	15.40	6.20	4.80	4.50	3.30	3.70	4.10	3.20	3.00	6.20
13	3.80	3.80	10.40	5.80	4.80	4.50	3.30	3.50	4.00	3.30	3.00	5.10
14	3.80	4.30	7.80	5.40	4.70	4.50	3.40	3.80	3.80	3.40	3.00	5.20
15	3.80	3.80	7.20	5.20	4.60	4.40	3.40	4.40	3.80	3.40	3.00	18.00
16	3.80	3.80	6.50	5.60	4.40	4.40	3.50	3.40	3.80	3.30	3.00	18.00
17	3.80	3.60	5.80	5.60	4.10	4.50	4.90	3.40	3.70	3.30	3.00	10.80
18	3.80	3.50	5.50	5.40	4.20	5.00	5.00	4.10	3.80	3.30	3.00	13.65
19	3.80	3.50	5.10	5.40	4.10	4.60	5.20	4.30	3.90	3.20	3.00	6.30
20	3.80	3.50	5.00	5.40	4.10	4.40	4.80	5.30	3.70	3.20	3.00	5.30
21	3.80	3.50	5.90	10.50	4.10	4.30	4.10	4.10	3.60	3.10	3.00	12.05
22	3.90	3.50	6.90	13.80	4.50	4.60	3.80	4.10	3.50	3.10	3.00	4.10
23	4.10	3.60	6.50	11.50	13.00	5.30	3.70	4.10	3.40	3.10	3.00	4.40
24	3.70	3.70	5.80	9.00	9.50	5.60	3.50	5.50	3.20	3.10	3.80	4.40
25	3.50	3.90	5.50	7.60	9.00	5.00	3.40	5.50	3.30	3.00	4.90	4.60
26	3.40	3.40	5.30	6.80	10.60	4.60	8.70	5.10	3.30	3.00	4.80	4.80
27	3.70	3.40	5.50	6.00	8.60	4.40	3.50	4.90	3.20	3.00	4.00	4.50
28	3.70	3.50	6.60	5.60	10.30	4.20	3.40	4.30	3.20	3.00	4.00	4.50
29	3.60	.....	6.50	5.30	12.60	4.00	3.40	4.20	3.50	3.00	3.90	5.20
30	3.50	.....	5.90	5.00	13.30	4.00	3.40	4.30	3.50	3.00	3.70	6.40
31	3.60	.....	5.40	.....	11.60	.....	3.40	4.30	.....	3.00	.....	7.70

[a] Gage broken.

SUSQUEHANNA RIVER AT HARRISBURG, PA.

This station was established by E. Mather, president of the Harrisburg water board, in 1890. Discharge measurements were first made by E. G. Paul on March 31, 1897, from the Walnut street bridge. The station is described in Water-Supply Paper No. 48, page 113. Results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 129. The datum of this gage is the low-water mark of 1803, which is recorded on a large rock above the bridge.

Following is a list of the discharge measurements of Susquehanna River and Pennsylvania Canal made by E. G. Paul since 1897. Figures of flow by months published in the Annual Reports of this office include in all instances the discharge of the Pennsylvania Canal, which averages about 360 second-feet.

List of discharge measurements of Susquehanna River and Pennsylvania Canal at Harrisburg, Pa.

Date.	Gage height.	Discharge of river.	Discharge of canal.
1897.	*Feet.*	*Sec.-ft.*	*Sec.-ft.*
March 31	5.42	58,868	
August 30	1.50	9,568	
September 16	0.58	3,963	
November 17	2.50	17,824	
1898.			
February 25	6.58	75,897	353
March 24	15.80	260,485	350
March 25	14.60	229,374	349
March 26	10.75	142,825	349
July 25	0.83	5,105	361
September 22	0.92	6,655	339
October 7	0.74	5,735	387
1899.			
June 11	1.75	11,373	373
July 29	0.91	5,174	360
September 12	0.75	5,042	363
October 25	0.16	3,265	360
1900.			
May 16	2.42	17,245	377
September 21	0.08	2,294	360
September 28	−0.04	1,965	
1901.			
August 12	2.70	19,749	274
October 23	1.85	12,557	

Daily gage height, in feet, of Susquehanna River at Harrisburg, Pa., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.25	2.58	1.75	7.16	5.16	12.58	3.08	1.66	3.50	2.08	1.41	3.08
2	2.08	4.00	1.66	6.00	4.58	10.41	2.83	1.83	3.75	2.41	1.41	3.00
3	1.66	3.33	1.75	5.66	4.50	8.91	2.58	1.75	4.75	2.33	1.33	2.75
4	1.66	3.25	1.83	6.25	4.41	7.83	2.33	1.58	5.16	2.33	1.33	2.75
5	1.75	3.25	2.33	7.50	5.16	7.16	2.25	1.50	4.83	2.33	1.25	3.08
6	1.66	3.08	2.50	7.83	5.00	6.33	2.16	1.25	4.16	2.41	1.25	2.66
7	1.41	3.16	2.58	8.66	4.58	5.50	2.33	1.66	3.58	2.16	1.25	2.75
8	1.16	3.16	2.50	11.41	4.08	5.50	2.16	2.58	3.16	1.83	1.16	2.25
9	1.50	3.16	3.00	12.75	3.75	6.00	2.08	2.75	2.83	1.75	1.16	2.16
10	1.50	3.00	3.25	11.50	3.66	5.75	2.08	2.50	2.50	1.75	1.16	2.58
11	1.66	2.83	6.41	10.00	3.41	5.50	2.00	2.33	2.50	1.66	1.16	4.50
12	2.00	2.91	11.75	8.66	3.83	5.00	1.91	2.75	2.33	1.66	1.00	7.00
13	2.00	2.83	11.83	7.50	4.16	4.66	1.91	2.41	2.41	1.66	1.08	7.00
14	2.50	2.75	9.33	6.91	4.50	4.25	1.83	2.00	2.83	1.83	1.25	6.16
15	3.50	2.75	7.50	6.16	5.16	3.91	1.91	1.75	2.33	2.41	1.33	9.25
16	3.33	2.58	6.66	5.91	5.08	3.50	1.75	1.66	2.25	2.66	1.58	21.41
17	3.41	2.75	6.25	5.75	4.66	3.75	1.66	1.66	2.41	2.50	1.66	18.58
18	2.91	2.58	5.75	5.33	4.16	3.58	2.08	1.75	2.41	2.08	1.91	14.16
19	2.58	2.50	5.25	5.00	4.00	3.50	2.41	5.50	2.50	2.08	1.91	9.83
20	1.75	2.50	5.00	4.75	4.25	3.25	2.25	5.83	2.66	2.00	1.91	7.41
21	1.75	2.08	5.91	5.50	4.08	3.08	2.00	5.00	2.58	2.00	1.75	6.16
22	1.83	2.00	8.50	11.00	4.00	3.25	1.83	4.08	2.58	1.91	1.75	4.83
23	2.00	2.00	9.50	13.58	5.50	3.75	1.75	4.16	2.41	1.91	1.58	3.83
24	1.75	1.91	9.08	12.16	8.41	3.83	1.66	4.75	2.33	1.83	1.83	3.58
25	2.00	1.91	8.00	10.16	7.50	4.00	1.58	7.75	2.08	1.83	2.50	3.75
26	1.75	1.91	7.66	8.16	8.00	3.91	1.50	9.09	2.00	1.66	3.08	3.75
27	2.00	1.75	8.33	8.50	7.50	3.70	1.58	7.25	1.83	1.58	5.41	3.91
28	2.00	1.75	11.75	7.25	7.00	3.25	1.66	5.75	1.75	1.66	5.25	3.91
29	2.00	.....	12.91	6.50	8.75	3.25	1.50	4.75	1.66	1.50	4.00	3.91
30	1.75	.....	11.16	5.75	12.25	3.16	1.50	4.00	1.66	1.41	3.58	5.58
31	1.66	.....	9.00	.....	13.91	.....	1.50	3.50	.....	1.41	.....	6.25

PATAPSCO RIVER AT WOODSTOCK, MD.

This station, which was established August 6, 1896, by E. G. Paul, is located at the county bridge, on the road from Woodstock to Granite, Md., 1½ miles below the junction of the North Branch. It is described in Water-Supply Paper No. 48, page 115, where will also be found the gage heights for 1900. The results of measurements for 1900 were published in the Twenty-second Annual Report, Part IV, page 130. During 1901 a measurement was made by Mr. Paul on July 31, the discharge being 144 second-feet, for a gage height of 3.50 feet.

Daily gage height, in feet, of Patapsco River at Woodstock, Md., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.45	3.65	3.95	3.85	4.00	3.95	3.60	3.45	(b)	(b)	3.65	4.05
2	3.45	3.75	3.95	3.55	4.05	4.05	3.45	3.45	(b)	(b)	3.65	4.05
3	3.45	3.80	3.95	6.55	4.05	4.00	3.35	3.45	(b)	4.05	3.70	4.60
4	3.45	3.90	3.95	4.60	4.05	4.00	3.35	3.35	(b)	4.00	3.85	4.25
5	3.45	3.85	3.95	4.25	4.05	3.85	3.70	3.45	(b)	3.90	3.75	4.10
6	3.40	3.85	3.95	4.25	4.05	3.60	3.40	3.70	(b)	3.75	3.65	4.00
7	3.50	3.75	3.95	4.35	4.05	5.00	3.70	5.40	(b)	3.85	3.55	4.05
8	3.55	3.65	3.95	4.05	4.10	4.15	4.30	4.00	(b)	3.70	3.30	4.15
9	3.55	3.70	4.75	4.00	4.05	3.85	3.95	3.65	(b)	3.60	3.25	4.20
10	3.65	3.70	5.80	4.05	4.00	3.80	3.60	3.65	(b)	3.35	3.30	4.20
11	3.60	3.80	8.35	4.05	4.05	3.75	3.30	3.55	(b)	3.40	3.40	4.15
12	4.30	3.80	6.05	4.05	4.05	3.65	4.50	6.40	(b)	3.40	3.35	4.25
13	4.30	(a)	5.80	4.05	4.05	3.60	3.95	3.70	(b)	4.05	3.45	4.80
14	3.85	(a)	5.75	4.55	4.00	3.60	4.15	3.80	(b)	4.10	3.35	7.85
15	3.85	(a)	5.75	4.75	4.00	4.05	3.95	3.70	(b)	4.05	3.35	6.00
16	3.80	(a)	5.60	4.10	3.80	4.30	3.80	3.70	(b)	3.80	3.45	4.80
17	3.80	3.85	4.05	4.05	3.80	4.20	4.00	3.75	(b)	3.65	3.50	4.75
18	3.70	3.85	4.05	4.15	3.75	3.90	4.00	3.75	(b)	3.65	3.55	4.75
19	3.70	3.85	4.05	4.05	3.70	4.00	4.00	5.86	(b)	3.80	3.50	4.75
20	3.70	3.85	4.05	4.25	3.65	3.85	3.70	4.25	(b)	3.80	3.60	4.50
21	3.75	3.85	5.30	5.25	3.70	3.85	3.75	3.90	(b)	3.85	3.50	4.75
22	3.60	3.85	4.75	4.50	3.65	3.85	3.70	3.85	(b)	3.40	3.65	4.75
23	3.60	3.95	4.05	4.25	3.55	3.75	3.55	3.85	(b)	3.35	3.80	4.75
24	3.55	3.95	4.05	4.50	3.60	3.60	3.45	3.85	(b)	3.50	5.85	4.75
25	3.70	3.95	4.05	4.70	4.75	3.50	4.30	4.25	(b)	3.65	4.10	4.75
26	4.00	3.90	4.00	4.30	5.15	3.35	4.60	3.60	(b)	3.85	3.80	4.75
27	3.80	3.85	4.10	4.25	5.50	3.50	3.55	3.60	(b)	3.35	3.90	4.60
28	3.85	3.95	4.05	4.15	4.35	3.25	3.55	3.60	(b)	3.50	3.90	5.35
29	3.85	.....	4.00	4.00	4.30	4.10	3.60	3.45	(b)	3.55	3.90	11.55
30	3.55	.....	3.85	4.05	4.15	3.80	3.45	3.45	(b)	3.75	4.05	5.05
31	3.65	.....	4.00	.....	4.00	.....	3.50	3.10	(b)	3.55	.....	4.60

[a] Ice.

[b] Gage broken.

NORTH BRANCH OF POTOMAC RIVER AT PIEDMONT, W. VA.

This station, which was established January 27, 1899, by E. G. Paul, is located at the highway bridge connecting Luke, Md., with Piedmont, W. Va. It is described in Water-Supply Paper No. 48, page 115, where will be found gage heights and discharge measurements for 1900. Results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 132. During 1901 the following measurements were made by Mr. Paul:

July 24: Gage height, 2.90 feet; discharge, 275 second-feet.
November 7: Gage height, 2.10 feet; discharge, 39 second-feet.

Daily gage height, in feet, of North Branch of Potomac River at Piedmont, W. Va., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.40	3.30	2.85	3.80	4.00	4.25	3.35	2.50	3.20	2.55	2.10	2.50
2	3.20	3.20	3.00	3.65	3.90	4.40	3.15	2.50	3.00	2.40	2.10	2.70
3	2.95	3.20	4.00	4.00	3.80	4.10	3.00	2.40	2.90	2.40	2.10	5.65
4	2.95	3.20	5.20	4.00	3.75	3.90	3.00	2.40	2.80	2.50	2.10	5.20
5	3.15	3.30	4.60	4.45	3.60	3.70	2.90	2.30	2.70	2.40	2.10	4.20
6	3.10	3.30	3.85	6.55	3.40	3.60	2.80	2.40	2.60	2.40	2.10	3.50
7	3.00	3.20	3.80	6.30	3.40	4.00	2.80	3.35	2.55	2.35	2.10	3.50
8	2.90	3.20	3.80	5.65	3.30	4.00	2.80	2.85	2.50	2.25	2.10	3.50
9	3.00	3.10	4.70	5.00	5.75	3.80	2.70	2.60	2.50	2.20	2.00	3.55
10	3.00	3.10	6.20	4.65	7.55	3.55	2.60	2.50	2.40	2.20	2.00	5.70
11	4.00	3.20	6.90	4.50	5.90	3.35	2.45	2.45	2.60	2.20	2.00	4.55
12	5.75	3.10	5.65	4.30	5.25	3.15	2.40	2.35	2.70	2.20	2.05	4.05
13	4.65	3.00	5.15	4.20	4.90	4.25	2.60	2.30	2.65	2.25	2.10	3.80
14	4.15	3.00	5.20	4.65	4.60	3.95	3.50	2.45	2.60	2.30	2.20	4.30
15	4.10	2.90	4.75	5.25	4.25	4.30	3.80	2.30	2.50	2.30	2.30	8.15
16	4.00	3.00	4.40	5.60	4.10	4.90	5.30	2.30	2.45	2.25	2.20	5.55
17	3.90	3.10	4.10	5.70	3.95	4.95	5.10	2.45	2.55	2.20	2.10	4.65
18	3.55	3.15	4.05	5.40	3.80	4.70	4.25	3.15	2.60	2.20	2.10	4.20
19	3.25	3.60	4.05	4.95	3.70	4.30	4.15	3.10	2.60	2.10	2.10	3.80
20	3.35	3.40	4.15	7.60	3.75	4.05	3.55	3.35	2.50	2.10	2.10	3.40
21	3.50	3.20	4.55	7.55	3.70	3.75	3.20	3.60	2.40	2.10	2.10	3.40
22	3.90	3.10	4.35	6.35	4.55	3.55	3.10	3.35	2.40	2.10	2.10	3.40
23	3.70	3.00	4.20	5.85	5.60	3.45	2.95	3.35	2.30	2.10	2.15	3.55
24	3.60	2.85	4.05	5.65	4.65	3.20	2.90	4.95	2.30	2.10	2.70	3.50
25	4.00	2.95	4.15	5.35	4.30	3.10	2.80	4.80	2.30	2.10	3.00	4.70
26	3.70	2.95	4.15	5.05	4.55	3.20	2.70	3.90	2.20	2.10	2.85	4.30
27	3.70	2.90	4.55	4.65	6.25	3.95	2.70	3.55	2.20	2.10	2.65	4.95
28	3.55	2.85	4.25	4.35	6.15	4.80	2.70	3.65	2.25	2.10	2.55	4.25
29	3.35	.....	4.05	4.20	5.90	4.40	2.60	3.45	2.90	2.10	2.45	6.65
30	3.50	.....	3.90	4.10	5.55	3.70	2.50	3.15	2.90	2.10	2.60	5.80
31	3.35	.....	3.75	.....	5.05	.....	2.50	3.00	.....	2.10	.....	4.80

SOUTH BRANCH OF POTOMAC RIVER NEAR SPRINGFIELD, W. VA.

The station on the South Branch at Springfield was originally (April, 1894) established at the railroad bridge 2 miles south of that town, by C. C. Babb, but was discontinued in 1896. The present station, which was established by E. G. Paul, January 26, 1899, is located on the iron highway bridge one-fourth of a mile from Grace station and 1 mile from Springfield. It is described in Water-Supply Paper No. 48, page 116, where will also be found the gage heights and discharge measurement for 1900. During 1901 the following measurements were made by Mr. Paul:

July 23: Gage height, 4.50 feet; discharge, 922 second-feet.
December 31: Gage height, 11.50 feet; discharge, 5,170 second-feet.

Daily gage height, in feet, of South Branch of Potomac River near Springfield, W. Va., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.40	(a)	(a)	4.80	5.80	7.60	5.00	3.60	9.10	4.00	3.20	3.40
2	3.40	(a)	(a)	4.50	5.60	6.80	5.00	3.40	4.60	4.20	3.40	3.40
3	(a)	(a)	3.80	4.20	5.40	6.20	5.40	3.10	4.40	4.60	3.40	3.40
4	(a)	4.00	3.80	8.20	5.50	5.80	5.60	3.10	4.40	3.80	3.30	7.00
5	(a)	4.00	5.00	8.60	5.00	5.80	5.60	3.10	4.20	3.60	3.30	6.40
6	(a)	(a)	(a)	9.40	4.90	6.00	5.30	3.60	4.20	3.60	3.20	6.00
7	(a)	(a)	4.50	8.60	4.50	6.40	5.80	4.20	4.10	3.50	3.20	(a)
8	(a)	(a)	4.60	8.00	4.80	6.20	5.80	4.00	4.10	3.50	3.20	4.80
9	3.60	(a)	4.80	7.60	6.10	5.40	5.40	3.60	4.10	3.50	3.20	4.60
10	3.60	(a)	4.80	6.80	16.50	5.00	5.00	3.20	4.00	3.40	3.20	4.50
11	3.80	(a)	12.20	6.40	12.10	4.80	4.80	3.80	4.00	3.40	3.10	4.50
12	7.60	(a)	11.40	5.80	8.20	4.50	4.20	3.80	4.00	3.40	3.10	4.50
13	9.20	(a)	9.40	5.60	7.40	4.40	4.00	3.60	5.20	3.30	3.10	4.80
14	8.00	(a)	8.20	6.40	6.50	5.30	4.00	3.60	5.40	3.30	3.10	5.80
15	6.40	(a)	7.40	11.20	6.00	5.60	6.00	3.50	5.00	3.20	3.10	20.00
16	5.60	(a)	6.00	10.00	5.80	12.40	6.20	3.50	4.40	3.20	3.10	15.00
17	5.40	(a)	5.80	9.20	5.60	10.20	6.50	3.50	3.80	3.20	3.10	11.20
18	5.40	(a)	5.40	9.00	5.20	8.10	6.80	3.40	3.60	3.20	3.10	6.80
19	5.20	(a)	5.20	8.60	5.00	7.80	5.40	3.40	3.60	3.20	3.10	5.70
20	(a)	(a)	5.20	10.50	5.00	7.00	5.00	3.80	3.60	3.20	3.10	(a)
21	(a)	(a)	5.00	18.40	4.80	6.10	4.20	4.00	3.50	3.20	3.10	(a)
22	(a)	(a)	6.80	16.00	11.50	5.60	4.00	4.20	3.50	3.10	3.00	(a)
23	(a)	(a)	7.00	12.20	9.00	5.40	4.50	4.50	3.50	3.10	3.00	(a)
24	4.40	(a)	7.00	8.90	7.60	5.40	4.00	3.80	3.40	3.10	3.00	(a)
25	4.40	(a)	6.80	8.40	5.40	5.20	3.80	3.80	3.40	3.10	5.20	(a)
26	4.20	(a)	6.50	7.60	5.00	5.60	4.20	3.50	3.40	3.10	4.60	(a)
27	4.20	(a)	6.20	7.20	6.50	6.40	3.60	3.50	3.40	3.10	4.00	(a)
28	4.20	(a)	6.00	6.80	8.70	6.00	3.40	4.00	3.30	3.10	3.80	(a)
29	(a)	.....	5.60	6.40	12.20	6.10	3.00	4.50	3.30	3.10	3.70	8.60
30	(a)	.....	5.40	6.00	11.60	5.00	3.00	4.50	3.20	3.10	3.50	14.60
31	(a)	.....	5.20	.....	8.40	5.00	3.90	4.40	.....	3.10	.....	12.20

[a] Ice.

ANTIETAM CREEK NEAR SHARPSBURG, MD.

This station was established at Myers's mill, 1 mile east of Sharpsburg, Md., on the road to Keedysville, Md., on June 24, 1897, by Arthur P. Davis. It is described in Water-Supply Paper No. 48, page 117, where will be found the gage heights for 1900. Results of discharge measurements for the year 1900 will be found in the Twenty-Second Annual Report, Part IV, page 134. During 1901 the following measurements were made by E. G. Paul:

July 30: Gage height, 1.90 feet; discharge, 185 second-feet.
December 28: Gage height, 2.20 feet; discharge, 266 second-feet.

Daily gage height, in feet, of Antietam River near Sharpsburg, Md., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.50	1.50	1.50	2.80	2.50	2.80	2.20	1.90	2.50	2.00	1.60	
2	1.50	1.40	1.50	2.70	2.50	2.80	2.10	1.80	2.30	1.90	1.60	
3	1.40	1.40	1.40	3.30	2.40	2.60	2.10	1.70	2.10	2.20	1.40	
4	1.40	1.40	1.50	5.25	2.40	2.50	2.00	1.70	2.00	2.00	1.50	
5	1.40	1.50	1.60	3.65	2.40	2.50	2.10	1.80	2.00	1.80	1.50	
6	1.40	1.60	1.50	3.40	2.30	2.50	2.10	2.10	1.90	1.80	1.50	
7	1.40	1.60	1.80	3.30	2.20	2.80	2.10	2.60	1.80	1.80	1.60	
8	1.40	1.50	1.70	3.20	2.30	2.70	2.10	2.40	1.70	1.70	1.60	
9	1.40	1.50	1.60	3.10	2.30	2.60	2.00	2.20	1.60	1.70	1.60	
10	1.50	1.40	1.60	2.85	2.20	2.40	2.00	2.00	1.60	1.60	1.60	
11	1.50	1.40	5.35	2.70	2.10	2.30	2.10	1.90	1.60	1.60	1.60	
12	1.70	1.40	3.35	2.60	2.30	2.30	2.20	1.80	1.70	1.60	1.60	
13	1.60	1.30	2.45	2.50	2.20	2.20	2.10	1.80	1.70	1.60	1.50	
14	1.60	1.50	2.20	2.70	2.20	2.20	2.10	1.70	1.60	1.70	1.50	
15	1.50	1.40	2.30	4.30	2.20	2.40	2.10	3.90	2.60	1.70	1.50	
16	1.50	1.60	2.20	3.45	2.20	2.80	2.20	2.20	2.00	1.60	1.40	
17	1.60	1.40	2.20	2.90	2.20	2.60	2.50	2.10	2.10	1.60		
18	1.50	1.50	2.10	2.70	2.20	2.50	2.20	2.00	2.00			
19	1.40	1.60	2.10	2.60	2.20	2.40	2.10	1.90	1.80	1.50		
20	1.40	1.60	2.00	2.95	2.15	2.30	2.00	1.80	1.70	1.60		
21	1.50	1.70	2.45	3.60	2.10	2.30	2.50	1.90	1.70	1.60		
22	1.50	1.70	2.40	3.60	4.80	2.30	2.20	1.80	1.70	1.50		
23	1.60	1.80	2.20	3.20	6.30	2.30	2.10	1.90	1.70	1.50		
24	1.60	1.60	2.20	3.00	3.70	2.30	2.10	2.00	1.70	1.50		
25	1.60	1.30	2.10	2.90	3.85	2.20	2.50	2.00	1.60	1.50		
26	1.60	1.40	2.20	2.80	3.40	2.20	2.10	2.00	1.60	1.80		
27	1.40	1.50	2.25	2.90	3.40	2.30	2.10	1.90	1.70	1.70		
28	1.40	1.50	2.20	2.80	3.10	2.30	2.00	1.70	1.70	1.70		2.20
29	1.50	.....	2.20	2.70	3.00	2.35	1.90	1.70	1.60	1.60		4.70
30	1.50	.....	2.10	2.60	3.50	2.20	1.90	1.70	2.15	1.70		4.50
31	1.50	.....	2.20	.....	3.00	.....	1.80	2.05		1.70		3.00

NORTH BRANCH OF SHENANDOAH RIVER NEAR RIVERTON, VA.

This station, which was established June 26, 1899, by Arthur P. Davis, is about 2 miles northwest of Riverton. It is described in Water-Supply Paper No. 48, page 118, where will be found records of discharge measurements made during 1900. On September 10, 1900, the gage was moved to the left bank of the river, and its datum changed 1 foot, causing all readings to be increased by 1 foot. Results of measurements for 1899 and 1900 will be found in the Twenty-second Annual Report, Part IV, page 135. A measurement was made July 20, 1901, by E. G. Paul, the discharge being 2,410 second-feet for a gage height of 5.95 feet.

Daily gage height, in feet, of North Branch of Shenandoah River near Riverton, Va., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.73	3.95	3.70	4.37	4.97	6.10	4.95	4.20	5.25	5.03	3.80	3.90
2	3.75	3.90	3.70	4.40	4.90	5.65	4.75	4.28	5.55	4.65	3.80	3.83
3	3.80	3.85	3.70	6.00	4.80	5.15	4.70	4.10	5.20	4.40	3.80	3.98
4	3.78	3.78	3.80	7.65	4.73	5.48	4.70	4.05	4.93	4.35	3.80	4.43
5	3.80	3.80	3.78	6.60	4.65	4.85	4.50	4.05	4.75	4.30	3.80	4.45
6	3.85	3.90	3.80	6.25	4.60	5.95	4.80	4.30	4.40	4.23	3.80	4.53
7	3.75	3.95	3.85	6.25	4.50	6.60	5.50	5.80	4.25	4.10	3.80	4.35
8	3.80	3.87	3.85	5.90	4.42	7.10	4.30	5.50	4.23	4.15	3.80	4.20
9	3.73	3.83	3.80	5.40	5.15	5.90	4.45	4.80	4.10	4.10	3.80	4.38
10	3.70	3.83	3.85	5.10	6.00	5.40	4.35	4.45	4.05	3.95	3.80	4.35
11	4.15	3.82	11.25	4.85	6.63	5.00	4.40	4.30	4.20	3.95	3.70	4.40
12	5.30	3.80	9.05	4.70	6.25	4.78	4.70	5.20	4.10	4.00	3.60	4.40
13	5.75	3.90	6.50	4.60	5.65	5.10	4.70	5.55	4.03	3.95	3.60	4.35
14	5.10	4.00	5.68	7.45	5.30	5.30	6.40	4.70	4.00	3.90	3.70	4.40
15	4.85	3.95	5.35	13.20	4.85	4.95	6.90	4.40	4.05	3.90	3.70	11.70
16	4.68	3.88	4.98	8.30	4.67	12.15	6.83	4.60	4.15	3.83	3.80	9.10
17	4.45	3.80	4.75	6.90	4.60	11.10	7.10	4.58	4.15	3.80	3.80	6.20
18	4.30	3.80	4.63	6.25	4.73	7.50	6.48	4.35	4.15	3.80	3.80	5.50
19	4.30	3.83	4.47	5.85	4.55	6.25	6.95	4.55	4.10	3.83	3.70	5.10
20	5.55	3.78	4.20	7.40	4.53	5.90	6.10	4.40	4.05	3.83	3.70	4.90
21	4.95	3.80	4.90	16.50	4.65	6.95	5.30	4.15	3.95	3.78	3.70	8.00
22	4.35	4.00	4.90	12.45	7.05	6.75	4.95	4.05	3.88	3.75	3.80	7.50
23	4.05	3.97	4.90	8.50	14.80	6.20	4.75	4.05	3.88	3.70	3.85	7.50
24	3.98	3.95	4.83	6.80	8.70	5.75	4.55	4.20	3.80	3.70	5.25	7.50
25	4.00	3.93	4.70	6.65	7.15	5.25	4.50	4.60	3.80	3.73	4.85	7.50
26	3.98	3.85	4.63	6.10	6.55	5.30	4.30	4.75	3.70	3.80	4.50	7.50
27	4.00	3.83	4.75	5.70	6.65	5.55	4.35	4.50	3.65	3.80	4.25	7.50
28	4.00	3.78	4.75	5.30	7.05	4.70	4.30	4.25	3.65	3.80	4.35	6.90
29	3.95	.....	4.57	5.10	8.20	5.40	4.15	4.30	5.15	3.80	4.05	8.20
30	3.93	.....	4.50	5.00	6.70	5.60	4.65	4.50	5.90	3.83	4.00	14.10
31	3.90	.....	4.45	.....	6.20	.....	4.35	4.90	.....	3.80	.....	8.25

SOUTH BRANCH OF SHENANDOAH RIVER AT FRONT ROYAL, VA.

This station was established by Arthur P. Davis on June 26, 1899. It is described in Water-Supply Paper No. 48, page 119, where will also be found a record of discharge measurements made in 1900. A measurement was made by E. G. Paul on July 21, 1901, the discharge obtained being 4,211 second-feet for a gage height of 6.95 feet.

Daily gage height, in feet, of South Branch of Shenandoah River at Front Royal, Va., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4.50	4.65	4.30	5.45	6.25	7.70	7.20	6.05	6.75	9.55	4.50	5.70
2	4.50	4.60	4.25	5.60	6.10	7.30	7.05	5.95	6.60	9.35	4.50	5.55
3	4.40	4.60	4.30	5.85	5.95	6.90	6.80	5.90	6.35	8.60	4.90	5.40
4	4.40	4.90	4.30	9.80	5.80	6.75	6.40	6.05	6.10	7.45	4.80	5.35
5	4.40	5.10	4.30	8.30	5.75	6.55	6.05	5.45	5.85	6.65	4.75	5.25
6	4.40	4.90	4.30	8.20	5.60	6.45	6.20	6.65	5.65	5.80	4.65	5.15
7	4.40	4.90	4.20	7.70	5.55	6.70	6.30	8.20	5.45	5.65	4.60	5.10
8	4.40	4.50	4.25	7.25	5.50	7.50	6.20	7.80	5.90	5.45	4.50	5.20
9	4.20	4.50	4.30	6.70	5.90	7.15	6.05	7.00	5.75	5.25	4.50	5.35
10	4.25	4.90	4.35	6.45	7.40	6.85	5.95	6.45	5.55	5.05	4.50	5.40
11	4.40	4.90	7.05	6.15	7.25	6.60	5.70	6.80	5.35	4.95	4.50	5.50
12	5.30	4.80	10.25	5.80	7.00	6.15	5.45	6.65	5.20	4.80	4.50	5.55
13	7.35	4.70	7.70	5.60	6.50	5.95	5.30	6.55	5.05	5.30	4.45	5.60
14	7.15	4.50	6.70	5.65	6.20	5.85	11.50	6.45	4.90	5.05	4.40	5.70
15	6.75	4.50	6.25	16.30	6.45	5.70	9.60	6.25	5.40	4.95	4.40	11.50
16	6.30	4.50	5.85	11.00	6.45	7.15	9.30	6.15	5.25	4.90	4.40	14.95
17	5.75	4.90	5.65	8.65	5.95	9.90	8.10	5.95	5.05	4.80	4.50	10.10
18	5.45	4.85	5.50	7.95	5.80	8.70	7.50	5.90	4.95	4.75	4.40	8.05
19	5.30	4.75	5.40	7.55	5.65	7.30	7.35	5.75	4.80	4.70	4.40	7.60
20	5.30	4.60	5.25	7.25	5.60	6.85	7.00	6.55	4.75	4.90	4.40	7.25
21	5.30	4.50	5.20	18.50	5.50	10.30	6.75	7.50	4.70	4.85	4.40	6.45
22	5.30	4.30	5.70	15.80	8.25	8.65	6.55	8.05	4.90	4.80	4.40	5.85
23	5.15	4.30	5.35	11.35	17.50	7.60	6.35	7.75	4.75	4.70	4.55	5.65
24	5.00	4.40	5.40	8.90	10.50	6.75	6.25	7.45	4.70	4.70	5.70	5.45
25	4.95	4.40	5.40	7.80	9.40	6.45	6.00	4.95	4.65	4.60	6.15	5.40
26	4.85	4.35	5.50	7.35	11.50	6.25	5.80	5.50	4.60	4.60	6.00	5.35
27	4.90	4.30	5.65	7.20	10.90	6.15	5.40	6.40	4.50	4.80	5.55	5.55
28	4.80	4.30	5.75	6.95	9.50	6.10	6.85	6.45	5.15	4.70	5.30	6.55
29	4.80	.....	5.95	6.65	8.90	6.00	6.70	6.25	6.90	4.60	4.95	10.00
30	4.70	.....	5.85	6.35	8.50	7.35	6.60	5.95	8.70	4.60	4.75	18.00
31	4.70	.....	5.50	.....	6.10	.....	6.35	5.80	.....	4.55	.....	13.50

SHENANDOAH RIVER AT MILLVILLE, W. VA.

This station, which was established April 15, 1895, is 4 miles above the mouth of Shenandoah River. It is described in Water-Supply Paper No. 48, page 121. Results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 136. During 1901 the following measurements were made by E. G. Paul:

July 22: Gage height, 3.30 feet; discharge, 5.419 second-feet.
December 27: Gage height, 2.35 feet; discharge, 3,291 second-feet.

Daily gage height, in feet, of Shenandoah River at Millville, W. Va., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	0.90	[a]1.50	0.70	2.00	3.00	4.70	3.50	1.60	2.80	3.70	0.95	1.30
2	.90	1.60	.70	1.95	2.80	4.20	2.70	1.50	3.30	2.80	.95	1.20
3	.90	1.10	.70	2.50	2.70	3.70	2.40	1.45	3.00	2.40	.90	1.25
4	.95	1.00	.75	5.35	2.50	3.35	2.20	1.45	2.80	2.10	.90	1.50
5	.70	1.20	.75	5.70	2.40	3.30	1.15	1.40	2.30	1.80	.90	1.70
6	.90	[a]2.30	.75	4.60	2.30	3.60	2.00	1.70	2.00	1.70	.90	1.80
7	.70	1.60	.80	4.20	2.20	4.10	2.50	2.10	1.90	1.50	.85	1.90
8	.80	1.60	.70	4.15	2.10	4.90	2.60	5.10	1.80	1.50	.85	1.80
9	.70	1.20	.80	3.60	2.10	4.50	2.00	3.80	1.60	1.50	.85	1.70
10	.80	1.20	.80	3.20	5.50	3.70	1.90	2.70	1.50	1.40	.85	1.70
11	.90	1.20	1.70	2.85	3.25	3.10	1.80	2.20	1.45	1.40	.85	1.70
12	2.10	.90	7.35	2.60	4.20	2.80	1.85	2.30	1.50	1.35	.85	1.70
13	2.30	1.20	5.30	2.40	3.50	2.60	2.10	3.10	1.90	1.35	.85	2.00
14	3.50	1.30	3.90	3.00	3.00	3.50	3.00	3.40	1.60	1.40	.80	2.00
15	2.90	1.30	3.20	10.25	2.70	2.90	4.30	2.60	1.50	1.35	.80	7.35
16	2.40	1.50	2.75	9.60	2.50	5.80	5.80	2.20	1.60	1.30	.80	10.50
17	2.10	1.00	2.40	6.10	2.30	10.10	5.20	2.75	1.50	1.20	.80	6.20
18	1.90	.90	2.20	4.90	2.25	5.70	4.20	2.60	1.50	1.10	.80	4.70
19	1.80	.80	2.60	4.30	2.20	4.60	4.30	2.60	1.45	1.10	.80	3.80
20	1.40	.80	1.80	4.60	2.15	3.90	3.90	2.60	1.40	1.10	.80	3.20
21	1.40	.80	2.00	10.55	2.00	3.50	3.50	2.20	1.30	1.00	.80	2.80
22	1.50	.90	2.20	([b])	2.50	5.70	3.20	2.10	1.25	1.00	.80	1.20
23	1.40	.90	2.40	8.50	11.10	5.50	2.70	2.00	1.20	1.00	1.00	1.20
24	1.30	.80	2.55	6.50	8.40	3.80	2.40	1.90	1.20	1.10	2.40	2.50
25	1.30	.90	2.30	5.30	6.30	3.20	2.20	2.20	1.15	1.00	2.70	2.40
26	1.30	.60	2.10	4.80	6.00	2.90	2.00	2.10	1.15	1.00	2.30	1.80
27	1.30	.80	2.10	4.30	6.70	2.90	2.10	2.20	1.10	1.00	1.80	2.30
28	1.30	.80	2.10	3.90	6.20	3.10	1.85	2.50	1.10	1.00	1.70	2.70
29	1.50	.....	2.60	3.50	6.30	2.70	1.80	2.60	1.30	1.00	1.50	4.00
30	1.40	.....	2.40	3.20	5.60	3.00	1.85	2.30	5.30	1.00	1.30	10.80
31	1.20	.....	2.15	.....	4.90	.....	1.80	3.00	.....	1.00	.....	[b]11.20

[a] Water backed by ice. [b] No reading; river out of banks; heights estimated.

POTOMAC RIVER AT POINT OF ROCKS, MD.

This station was established February 17, 1895, at the toll bridge over Potomac River at Point of Rocks, and is described in Water-Supply Paper No. 48, pages 121 to 124, where are also given the discharge measurements and records of gage heights for the years 1895 to 1900, inclusive. Revised results of measurements for the entire period will be found in the Twenty-second Annual Report, Part IV, page 137. The following discharge measurements were made at this station by E. G. Paul:

April 16: Gage height, 14.3 feet; discharge, 100,833 second-feet.
July 29: Gage height, 1.85 feet; discharge, 6,530 second-feet.
December 27: Gage height, 2.89 feet; discharge, 11,414 second-feet.

Daily gage height, in feet, of Potomac River at Point of Rocks, Md., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	0.80	1.20	0.80	2.20	3.40	7.50	2.60	1.70	2.80	3.00	0.90	1.60
2	.90	1.10	.80	2.00	3.10	6.00	2.40	1.50	5.70	2.40	.90	1.50
3	.90	1.00	.80	3.30	2.80	4.80	2.30	1.40	5.30	2.10	1.00	1.40
4	.90	1.10	.80	5.40	2.60	4.00	2.10	1.40	4.10	1.90	1.00	1.70
5	.90	1.10	.80	7.70	2.50	3.50	2.00	1.30	3.20	1.70	.90	3.50
6	.80	1.10	.90	6.80	2.30	4.00	2.00	1.30	2.30	1.70	.90	2.90
7	.70	1.30	1.80	6.80	2.10	4.70	1.90	1.60	2.00	1.50	.90	2.60
8	.70	1.20	1.40	7.80	1.90	4.80	2.20	4.50	1.80	1.40	.90	2.40
9	.60	1.20	1.30	6.30	1.80	4.10	2.00	3.50	1.70	1.40	.90	2.20
10	.60	1.20	2.70	5.30	2.00	3.20	1.70	2.80	1.70	1.30	.90	2.30
11	.70	1.30	4.20	4.20	8.05	2.70	1.60	2.30	1.60	1.30	.90	2.80
12	1.10	1.40	12.35	3.30	9.10	2.50	1.50	2.30	1.60	1.30	.90	3.20
13	1.80	1.70	9.90	3.00	6.00	2.20	1.60	2.20	1.50	1.20	.90	3.00
14	4.60	1.70	6.20	3.20	4.60	2.40	2.00	2.20	1.50	1.20	.80	2.80
15	3.50	1.80	4.50	9.00	3.50	2.70	3.60	2.10	1.50	1.20	.80	8.10
16	2.80	1.70	3.90	15.00	3.00	3.00	5.10	2.00	1.80	1.20	.90	17.20
17	2.20	1.40	3.20	8.30	2.70	5.70	5.20	2.00	1.60	1.10	.90	13.30
18	2.00	1.10	2.80	7.40	2.40	8.50	5.50	2.50	1.50	1.10	.90	6.90
19	1.90	1.10	2.50	6.20	2.30	5.60	5.10	2.40	1.50	1.10	.90	5.00
20	1.70	1.00	2.30	5.40	2.20	4.50	4.60	2.60	1.40	1.10	.90	4.10
21	1.50	.90	2.50	11.35	2.00	3.70	3.60	3.00	1.40	1.10	.90	3.20
22	1.40	.90	3.00	20.80	1.90	5.60	3.10	2.70	1.40	1.10	.90	3.00
23	1.30	.80	3.20	15.75	12.55	4.60	2.80	2.30	1.30	1.10	.90	2.70
24	1.30	.90	3.30	11.20	14.20	4.50	2.50	2.00	1.30	1.00	1.80	2.50
25	1.40	.90	2.80	7.90	9.30	4.30	2.20	2.00	1.30	1.00	4.10	2.50
26	1.50	.90	2.50	6.60	7.20	4.00	2.10	2.00	1.20	1.00	4.40	2.70
27	1.50	1.00	2.60	5.60	7.50	3.60	2.20	2.20	1.20	1.00	3.20	3.00
28	1.30	1.00	2.50	4.80	7.60	3.30	2.00	2.70	1.20	.90	2.50	2.90
29	3.90	.....	2.60	4.20	9.00	3.00	1.80	2.40	1.20	.90	2.00	4.40
30	1.00	.....	2.70	3.80	9.70	2.80	1.70	2.20	3.20	.90	1.70	13.80
31	1.20	.....	2.40	.....	8.60	.....	1.70	2.30	.....	.90	.....	18.40

MONOCACY RIVER, NEAR FREDERICK, MD.

This station was established August 4, 1896, by E. G. Paul, at the county bridge on the turnpike, 4 miles northeast of Frederick, on the road leading from Frederick to Mount Pleasant, Md. It is described in Water-Supply Paper No. 48, page 125. Records of discharge measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 139. During 1901 the following measurements were made by Mr. Paul:

July 31: Gage height, 4.10 feet; discharge, 179 second-feet.
December 28: Gage height, 6.30 feet; discharge 1,226 second-feet.

Daily gage height, in feet, of Monocacy River near Frederick, Md., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4.40	4.60	4.50	5.70	5.90	6.00	4.30	4.10	4.30	5.20	4.20	4.90
2	4.20	4.40	4.50	5.60	5.80	5.60	4.30	4.00	4.90	5.10	4.20	4.70
3	4.20	4.40	4.40	17.85	5.60	5.40	4.20	4.00	4.50	4.90	4.20	4.90
4	4.30	4.40	5.00	15.50	5.40	5.30	4.20	4.00	4.40	4.80	4.20	4.90
5	4.30	4.80	5.50	10.50	5.30	5.30	4.20	4.00	4.30	4.60	4.20	4.90
6	4.20	4.80	5.30	7.90	5.20	5.00	4.40	5.40	4.30	4.40	4.20	4.90
7	4.10	4.70	5.00	8.30	5.10	5.50	4.30	7.10	4.30	4.30	4.20	4.80
8	4.00	4.60	5.00	7.20	5.10	7.10	4.30	6.00	4.30	4.30	4.30	4.80
9	4.10	4.50	5.10	6.50	5.10	5.40	4.20	4.70	4.30	4.20	4.30	4.80
10	4.10	4.50	5.50	6.20	5.50	5.20	4.10	4.60	4.20	4.20	4.30	7.50
11	5.50	4.50	20.53	5.90	5.50	4.90	4.10	4.20	4.20	4.20	4.30	6.50
12	7.60	4.50	11.90	5.60	5.40	4.90	5.10	4.10	4.20	4.10	4.30	6.10
13	6.90	4.40	8.00	5.60	5.30	8.00	5.50	4.60	4.20	4.10	4.30	5.30
14	6.40	4.30	7.30	5.40	5.10	6.40	4.80	4.40	4.20	4.80	4.30	5.40
15	5.90	4.30	6.90	6.90	4.90	6.75	4.80	4.30	4.20	5.00	4.30	19.75
16	4.90	4.30	6.10	6.50	4.90	7.45	4.90	5.60	5.50	4.90	4.30	9.50
17	4.80	4.30	5.90	6.30	4.90	7.20	5.00	4.90	4.70	4.80	4.20	7.10
18	4.70	4.30	5.80	5.90	4.90	6.10	4.90	5.10	4.50	4.40	4.20	6.90
19	4.70	4.40	5.60	5.50	4.85	5.90	5.20	4.50	4.50	4.20	4.20	6.50
20	4.50	4.90	5.30	9.60	4.80	5.40	5.10	6.40	4.40	4.20	4.20	6.20
21	4.30	5.00	10.50	14.60	4.80	5.20	5.10	6.10	4.30	4.10	4.20	6.00
22	4.30	5.10	7.60	9.60	4.80	5.20	4.90	5.20	4.30	4.10	4.20	5.90
23	4.20	5.00	7.10	8.10	11.30	5.10	4.50	4.50	4.20	4.10	4.50	5.90
24	4.20	5.00	6.00	8.50	9.10	4.90	4.40	4.60	4.10	4.10	9.40	5.70
25	4.20	4.90	6.00	7.90	7.90	4.70	4.20	5.00	4.10	4.10	7.50	5.50
26	4.30	4.80	6.10	7.30	7.10	4.60	4.20	4.90	4.10	4.20	5.90	5.50
27	4.30	4.60	13.58	6.90	9.00	4.50	4.50	4.50	4.10	4.20	5.50	7.35
28	4.30	4.50	10.40	6.40	9.20	4.50	4.30	4.30	4.10	4.20	5.50	6.50
29	4.80	.....	7.40	6.10	11.50	4.50	4.20	4.20	4.70	4.20	5.10	13.25
30	4.70	.....	5.90	6.00	9.10	4.50	4.20	4.20	6.70	4.20	5.00	18.50
31	4.70	.....	5.80	.....	8.60	.....	4.10	4.20	.....	4.20	.....	12.50

NORTH (OF JAMES) RIVER AT GLASGOW, VA.

This station, which was established August 21, 1895, by C. C. Babb and D. C. Humphreys, is at the East Glasgow county bridge about 1 mile above the mouth of the river. It is described in Water-Supply Paper No. 48, page 127. Results of measurements made in 1900 will be found in the Twenty-second Annual Report, Part IV, page 145. During 1901 the following measurements were made by D. C. Humphreys:

April 23: Gage height, 4.25 feet; discharge, 4,342 second-fee'
July 16: Gage height, 2.74 feet; discharge, 2,028 second-feet.
August 7: Gage height, 5.14 feet; discharge, 7,121 second-feet.

Daily gage height, in feet, of North (of James) River at Glasgow, Va., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	0.93	1.10	0.81	1.68	2.00	2.25	2.40	1.05	3.35	1.75	0.83	0.80
2	.90	1.12	.80	1.60	1.90	2.15	2.00	1.00	2.65	1.60	.82	.78
3	.88	1.10	.80	5.80	1.80	2.10	2.00	1.02	2.30	1.48	.80	.82
4	.85	1.08	.80	3.90	1.70	2.00	2.05	1.00	2.00	1.40	.80	1.60
5	.83	1.06	.90	3.55	1.60	1.90	1.90	.95	1.65	1.35	.82	1.50
6	.80	1.05	.90	3.20	1.55	1.55	1.80	5.50	1.62	1.30	.80	1.40
7	.80	1.08	.80	2.90	1.50	2.45	1.75	5.50	1.50	1.25	.78	1.15
8	.80	1.08	.80	2.85	1.50	2.65	1.60	3.05	1.42	1.20	.80	1.00
9	.80	1.05	.80	2.50	1.65	2.25	1.50	2.35	1.35	1.18	.80	1.00
10	1.80	1.05	1.00	2.25	1.75	2.10	1.35	1.90	1.25	1.15	.75	1.35
11	1.80	1.04	5.50	2.00	3.50	1.85	1.30	1.55	1.25	1.10	.70	1.75
12	[a]2.75	.98	5.40	1.90	2.35	2.05	1.25	1.70	1.25	1.05	.72	1.55
13	3.70	.96	3.90	1.80	2.15	1.75	1.25	2.50	1.20	1.05	.76	1.40
14	2.90	.95	3.50	2.60	1.95	2.25	1.68	2.65	1.20	1.00	.78	[a]6.35
15	2.35	.94	3.10	5.50	1.90	4.25	2.45	4.10	1.20	1.00	.80	11.30
16	2.15	.92	2.75	4.60	1.85	8.90	2.60	4.00	1.30	.95	.78	5.30
17	1.96	.91	2.50	3.75	1.80	4.90	2.80	3.35	1.30	.90	.78	3.30
18	1.62	.92	2.40	3.25	1.76	4.00	2.25	3.35	1.25	.90	.80	2.80
19	1.55	.92	2.30	3.25	1.60	3.40	1.80	2.90	1.25	.88	.75	2.30
20	1.50	.90	2.16	4.60	1.60	3.85	1.80	2.55	1.25	.85	.73	2.10
21	1.45	.90	3.00	8.00	1.52	2.60	1.75	2.15	1.20	.82	.75	1.70
22	1.40	.88	2.60	5.75	2.30	2.60	1.65	1.98	1.20	.80	.73	1.70
23	1.30	.85	2.20	4.40	8.00	2.40	1.48	1.75	1.30	.82	.73	1.70
24	1.25	.80	2.00	3.35	4.60	2.35	1.40	1.75	1.25	.82	1.20	1.65
25	1.22	.80	1.90	2.32	4.10	2.00	1.30	1.80	1.20	.85	1.10	1.60
26	1.20	.80	1.83	2.22	[a]4.26	1.85	1.25	1.90	1.18	.88	1.00	1.70
27	1.18	.80	4.50	2.20	4.42	2.70	1.20	2.15	1.28	.85	.90	3.60
28	1.15	.80	3.20	2.20	3.15	2.40	1.15	2.30	1.50	.82	.85	2.60
29	1.12	.....	2.50	2.18	2.95	2.10	1.10	1.90	1.90	.83	.80	13.80
30	1.10	.....	2.00	2.10	2.60	2.60	1.08	1.80	1.85	.85	.80	7.40
31	1.10	.....	1.80	.....	2.50	.....	1.10	1.80	.....	.85	.....	5.80

[a] Estimated.

JAMES RIVER AT BUCHANAN, VA.

This station, which was established August 18, 1895, by C. C. Babb and D. C. Humphreys, is located about 20 miles above the mouth of North River and a half mile above the mouth of Purgatory Creek. It is described in Water-Supply Paper No. 48, page 128. Records of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 146. During 1901 the following measurements were made by D. C. Humphreys:

March 28: Gage height, 5.74 feet; discharge, 6,664 second-feet.
August 1; Gage height, 2.63 feet; discharge, 907 second-feet.
August 15: Gage height, 8.50 feet; discharge, 14,748 second-feet.

Daily gage height, in feet, of James River at Buchanan, Va., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.80	2.90	2.50	3.90	4.00	5.25	4.20	2.60	6.60	3.15	2.20	2.20
2	2.80	2.80	2.50	4.00	3.90	4.75	3.95	2.50	5.00	3.00	2.20	2.20
3	2.70	2.80	2.50	9.85	3.80	4.35	3.70	2.50	4.20	2.90	2.20	2.45
4	2.70	2.90	2.60	10.25	3.65	4.15	3.85	2.50	3.65	2.80	2.10	2.90
5	2.60	2.90	2.60	8.95	3.50	3.85	4.55	2.50	3.35	2.70	2.10	3.45
6	2.60	3.00	2.70	6.35	3.40	3.65	4.35	6.10	3.20	2.60	2.10	3.25
7	2.60	3.10	2.70	6.10	3.50	5.35	4.05	9.75	3.10	2.50	2.10	2.95
8	2.60	3.10	2.80	5.90	3.20	4.60	3.85	5.40	3.00	2.40	2.10	2.80
9	2.60	3.10	2.90	5.20	3.30	4.15	3.55	4.30	2.90	2.40	2.10	2.80
10	2.50	3.20	2.90	4.70	3.70	3.75	3.25	3.80	2.80	2.40	2.10	2.70
11	3.35	3.35	9.00	4.35	4.80	3.60	3.10	3.60	2.80	2.40	2.10	3.15
12	9.85	3.20	7.85	4.05	4.50	3.50	3.00	3.60	3.00	2.40	2.10	3.40
13	7.65	3.10	6.35	3.90	4.05	3.50	2.85	4.90	2.90	2.50	2.10	3.30
14	5.80	3.10	5.55	4.65	3.75	3.40	3.45	6.80	2.80	2.50	2.10	3.20
15	5.10	3.10	4.70	8.50	3.55	6.20	4.65	9.30	2.70	2.50	2.00	14.90
16	4.60	3.00	4.25	6.95	3.40	11.60	5.20	8.25	2.70	2.40	2.00	10.90
17	4.20	3.00	3.95	5.80	3.30	8.20	5.35	6.40	2.70	2.40	2.00	6.45
18	3.85	2.90	3.65	5.45	3.20	7.10	5.05	5.80	2.70	2.30	2.00	5.25
19	3.65	2.90	3.55	5.15	3.20	6.05	4.85	5.15	2.70	2.30	2.00	4.50
20	3.35	2.90	3.40	9.75	3.20	5.30	4.40	4.60	2.60	2.30	2.00	4.15
21	3.20	2.80	3.70	12.20	3.30	5.20	3.95	4.15	2.60	2.30	2.00	3.65
22	3.20	2.80	3.90	9.30	8.65	6.00	3.55	3.90	2.60	2.30	2.00	3.40
23	3.20	2.70	4.00	7.80	13.60	6.10	3.25	3.75	2.60	2.30	2.05	3.40
24	3.10	2.70	3.85	6.90	8.25	6.35	3.10	3.75	2.50	2.20	2.50	3.40
25	3.20	2.60	3.80	6.35	6.75	5.60	3.00	3.90	2.50	2.20	2.60	3.45
26	3.35	2.60	4.55	5.70	5.85	4.75	2.90	3.80	2.40	2.20	2.50	4.10
27	3.30	2.60	7.10	5.25	8.60	4.35	2.80	4.25	2.40	2.20	2.40	5.25
28	3.20	2.50	5.80	4.80	9.60	4.20	2.70	4.10	2.50	2.20	2.30	5.75
29	3.20	.....	5.25	4.45	8.35	4.20	2.70	3.80	3.20	2.20	2.30	15.05
30	3.10	.....	4.70	4.15	6.70	4.55	2.60	3.55	3.30	2.20	2.20	19.25
31	3.00	.....	4.10	.....	5.85	.....	2.60	3.55	.....	2.20	.....	10.30

JAMES RIVER AT HOLCOMB ROCK, VA.

This station, which was established in 1889 by the Willson Aluminum Company of Holcomb Rock, Va., in connection with measurements to determine the horsepower available at that point, is described in Water-Supply Paper No. 48, page 129. Daily gage records for 1901 were furnished to the Geological Survey through the courtesy of Mr. T. R. Ragland, general manager of the company. No measurements of discharge are made at this point.

Daily gage height, in feet, of James River at Holcomb Rock, Va., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.50	1.60	1.20	2.85	3.00	4.60	2.90	1.40	5.50	2.20	1.00	1.00
2	1.50	1.60	1.20	2.65	2.80	3.75	2.10	1.40	4.80	1.80	1.00	1.15
3	1.50	1.65	1.20	8.60	2.55	3.50	2.75	1.40	3.40	1.60	1.00	1.60
4	1.50	1.90	1.20	11.60	2.40	3.20	2.70	1.40	2.70	1.50	1.00	1.70
5	1.50	1.70	1.20	7.90	2.20	2.75	2.60	1.50	2.25	1.45	1.00	1.80
6	1.40	1.70	1.20	6.10	2.20	2.55	2.50	6.30	2.05	1.50	1.00	1.80
7	1.40	1.70	1.40	5.90	2.05	4.56	2.40	11.00	1.90	1.45	1.00	1.80
8	1.40	1.70	1.40	5.50	2.00	4.00	2.35	5.65	1.70	1.35	1.00	1.55
9	1.35	1.70	1.30	4.40	2.00	3.25	2.15	3.70	1.70	1.30	1.00	2.10
10	1.25	1.75	1.30	3.70	2.35	2.90	2.00	2.75	1.50	1.30	1.00	2.05
11	1.60	1.80	8.20	3.25	4.10	2.45	1.90	2.65	1.90	1.30	1.00	2.00
12	9.00	1.80	9.70	2.95	3.80	2.30	1.65	2.85	1.70	1.30	1.00	1.90
13	8.70	1.75	5.75	2.65	3.30	2.60	1.60	2.80	1.70	1.30	1.00	1.80
14	5.60	1.60	4.35	3.95	2.55	2.40	1.50	6.55	1.65	1.40	1.00	1.80
15	4.30	1.55	3.60	9.15	2.30	4.85	4.30	9.75	1.40	1.30	1.00	13.00
16	3.60	1.60	3.15	6.90	2.20	12.10	4.60	8.95	1.55	1.25	1.00	10.00
17	3.15	1.75	2.60	5.50	2.10	9.25	4.65	6.50	1.45	1.30	1.00	6.00
18	2.70	1.80	2.40	4.90	2.00	7.55	4.15	5.80	1.65	1.30	1.00	4.00
19	2.35	1.55	2.30	4.30	2.00	6.00	4.05	4.90	1.55	1.30	1.00	3.50
20	2.15	1.50	3.40	9.70	1.95	4.80	3.70	4.00	1.59	1.30	1.00	3.00
21	1.95	1.50	3.55	15.45	1.90	4.40	3.15	3.40	1.20	1.30	1.00	3.00
22	1.90	1.40	3.45	10.60	6.60	4.40	2.55	2.95	1.50	1.30	1.00	2.90
23	1.85	1.40	3.15	8.50	14.75	4.40	2.00	2.65	1.50	1.05	1.00	2.80
24	1.80	1.30	2.65	6.95	8.80	4.40	1.90	2.90	1.35	1.00	1.35	2.80
25	1.80	1.30	2.50	6.20	6.35	4.40	1.80	3.55	1.25	1.00	1.60	2.70
26	1.80	1.30	2.55	5.30	6.10	2.95	1.90	3.45	1.20	1.00	1.55	2.70
27	1.80	1.35	6.50	4.65	7.45	2.85	2.00	3.40	1.20	1.00	1.35	2.70
28	1.80	1.30	5.80	3.95	9.70	2.50	1.85	3.45	1.30	1.00	1.20	2.70
29	1.70	.....	4.35	3.60	8.50	3.15	1.50	2.90	2.30	.95	1.10	2.50
30	1.60	.....	3.55	3.20	6.85	3.00	1.40	2.45	2.60	1.00	1.10	2.00
31	1.60	.....	3.05	.....	5.40	.....	1.40	2.75	.....	1.05	.....	1.20

JAMES RIVER AT CARTERSVILLE, VA.

This station, which was established January 1, 1899, by D. C. Humphreys, is located at the highway bridge crossing the James at Cartersville, a half mile from the railroad station and 50 miles above Richmond, Va. It is described in Water-Supply Paper No. 48, page 129. Results of measurements for 1899 and 1900 will be found in the Twenty-second Annual Report, Part IV, page 147. During 1901 the following discharge measurements were made by D. C. Humphreys:

July 26: Gage height, 2.36 feet; discharge, 4,136 second-feet.
August 9: Gage height, 8 feet; discharge 19,697 second-feet.

Daily gage height, in feet, of James River at Cartersville, Va., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.00	2.35	1.60	4.37	5.25	8.10	4.90	3.40	4.11	5.70	1.53	1.61
2	2.00	2.15	1.60	3.65	5.10	6.50	4.45	1.80	5.30	4.10	1.50	1.60
3	1.90	2.10	1.60	13.50	4.10	5.98	4.75	1.80	6.23	3.75	1.50	3.00
4	1.85	2.50	1.69	14.00	3.80	5.50	4.35	1.62	4.89	3.12	1.48	4.52
5	1.85	2.70	1.55	13.10	3.55	6.40	4.05	1.55	4.03	2.65	1.47	3.38
6	1.80	2.62	1.55	13.00	3.35	6.60	3.65	6.20	3.44	2.55	1.50	3.15
7	1.77	2.55	1.53	8.20	3.10	6.67	3.67	13.46	3.10	2.33	1.48	2.85
8	1.72	2.48	1.50	7.50	3.00	7.50	3.70	11.35	3.00	2.20	1.48	2.70
9	1.70	2.42	1.50	6.70	4.75	7.30	3.60	7.80	2.82	2.15	1.48	2.52
10	1.95	2.40	1.50	5.90	3.70	7.00	2.90	5.28	2.71	2.00	1.47	2.35
11	8.20	2.35	2.20	5.80	4.45	6.45	2.70	5.88	4.40	2.00	1.47	2.82
12	11.00	2.25	9.27	4.60	6.20	4.80	2.60	11.28	3.85	1.95	1.47	2.73
13	[a]11.80	2.25	11.00	4.05	5.10	4.55	2.70	9.25	2.85	1.90	1.47	2.52
14	12.62	2.20	6.95	10.12	4.48	4.22	3.02	6.68	2.40	2.05	1.47	3.00
15	10.72	2.20	6.50	15.60	4.70	3.85	5.90	16.30	2.30	2.05	1.45	10.00
16	9.62	2.20	6.30	12.50	4.45	11.00	6.45	12.55	2.20	2.00	1.45	18.00
17	5.80	2.10	4.20	9.50	4.40	17.82	6.30	11.88	2.00	1.98	1.43	16.50
18	5.30	2.10	3.60	8.50	4.00	12.10	7.30	9.70	2.55	1.85	1.33	7.85
19	3.60	2.05	3.25	8.10	2.87	11.45	6.35	7.95	3.00	1.75	1.32	6.50
20	3.00	2.05	3.00	7.90	2.87	9.19	6.15	6.77	2.65	1.73	1.32	5.75
21	2.85	2.02	2.95	14.80	7.75	7.80	5.20	5.71	2.35	1.68	1.32	4.55
22	2.85	2.02	3.30	21.05	17.35	7.10	4.40	4.90	2.20	1.62	1.31	4.00
23	2.62	2.00	3.95	15.45	24.50	7.00	3.75	4.27	2.15	1.62	1.30	3.30
24	2.60	1.90	4.30	12.22	18.80	6.95	3.15	5.60	2.10	1.62	4.70	3.35
25	2.60	1.88	3.65	9.00	12.45	6.90	2.80	5.62	2.05	1.58	3.30	3.45
26	2.85	1.85	3.50	8.10	9.80	6.50	2.35	6.30	2.03	1.58	2.40	3.60
27	2.63	1.80	5.00	7.10	8.80	5.35	2.23	6.20	2.00	1.55	2.15	4.45
28	2.54	1.65	6.30	6.55	10.50	5.15	2.00	7.11	2.25	1.50	1.90	5.38
29	2.52	.....	7.00	6.10	11.10	5.10	2.18	6.55	9.05	1.45	1.85	14.82
30	2.32	.....	5.50	5.55	10.45	4.73	1.83	4.40	10.00	1.53	1.53	25.38
31	2.40	.....	4.60	.....	8.50	.....	2.00	4.01	.....	1.50	.....	24.28

[a] Approximate.

APPOMATTOX RIVER AT MATTOAX, VA.

This station was established in August, 1900, at the crossing of the Southern Railway, 27 miles southwest of Richmond. It is described in Water-Supply Paper No. 48, page 126. During 1901 the following measurements were made by E. W. Myers and E. Graves:

January 16: Gage height, 4.36 feet; discharge, 820 second-feet.
April 23: Gage height, 6.74 feet; discharge, 1,696 second-feet.
May 23: Gage height, 10.73 feet; discharge, 3,694 second-feet.
July 22: Gage height, 1.26 feet; discharge, 270 second-feet.
November 26: Gage height, 4.40 feet; discharge, 826 second-feet.

Daily gage height, in feet, of Appomattox River at Mattoax, Va., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.00	2.35	1.50	2.50	2.40	3.70	1.40	1.20	3.40	5.70	1.50	1.80
2	2.70	2.20	1.50	2.35	2.30	3.40	1.60	.90	3.00	3.55	1.50	1.75
3	2.10	2.10	1.50	12.72	2.25	3.05	3.10	.80	2.80	3.00	1.50	1.80
4	1.75	2.20	1.55	14.60	2.20	3.00	2.10	.75	2.60	2.80	1.55	8.00
5	1.50	3.40	1.50	15.72	2.10	3.40	1.40	.80	2.20	2.30	1.55	8.80
6	1.40	3.25	1.50	18.00	2.00	2.70	1.10	2.00	2.15	2.00	1.55	4.50
7	1.90	2.50	1.50	14.00	2.00	2.50	1.75	13.00	2.05	1.90	1.55	3.10
8	1.60	2.22	1.40	5.20	1.95	3.40	2.15	12.75	1.95	1.80	1.55	2.50
9	1.60	2.35	1.45	4.15	2.00	3.45	3.60	14.00	1.90	1.80	1.50	2.45
10	1.50	2.50	1.85	3.50	4.95	2.50	2.85	15.50	3.30	1.75	1.50	2.60
11	1.90	2.75	3.15	3.05	5.50	2.20	3.60	3.55	2.30	1.70	1.50	2.75
12	9.50	2.45	3.15	2.75	5.00	2.15	2.25	2.90	1.90	1.70	1.50	2.50
13	12.00	2.15	3.00	2.50	3.00	1.90	1.90	2.75	1.80	1.70	1.50	2.25
14	13.00	2.00	2.30	4.50	2.10	1.80	4.20	8.30	2.00	1.80	1.50	2.20
15	13.85	1.90	2.00	13.50	2.00	1.90	7.20	13.50	1.60	2.00	1.50	6.00
16	8.00	1.80	1.80	13.80	1.90	2.90	7.90	12.80	1.55	1.90	1.50	9.50
17	3.55	1.85	1.70	17.50	1.85	3.40	5.60	14.00	2.20	1.80	1.50	10.20
18	3.50	1.85	1.60	16.50	1.80	4.40	3.90	14.25	2.10	1.70	1.45	10.60
19	3.40	1.75	1.50	4.70	1.70	4.15	3.95	5.00	4.20	1.65	1.45	3.50
20	3.70	1.80	1.50	5.15	1.85	2.80	3.20	4.50	5.45	1.55	1.45	2.75
21	2.40	1.75	2.00	4.75	1.80	2.20	2.60	3.80	3.20	1.50	1.45	2.45
22	2.50	1.60	2.20	6.35	1.80	2.15	1.90	3.30	2.50	1.50	1.45	2.30
23	2.45	1.55	2.40	6.65	10.60	2.10	1.65	2.25	2.15	1.50	1.45	2.80
24	2.35	1.45	1.90	5.00	17.62	1.90	1.50	5.50	2.00	1.50	3.20	2.80
25	2.75	1.45	1.75	4.40	24.60	1.80	1.20	11.50	1.90	1.50	5.30	3.50
26	3.05	1.60	3.10	3.80	21.90	1.55	1.00	12.50	1.80	1.45	3.20	4.80
27	2.82	1.80	8.10	3.35	16.90	1.40	1.10	14.10	1.75	1.45	2.50	7.50
28	2.50	1.55	9.10	3.00	14.10	1.40	3.00	14.90	1.75	1.45	2.20	9.20
29	2.22	.....	6.50	2.70	14.60	1.45	3.25	9.70	2.10	1.45	2.15	10.50
30	2.10	.....	3.50	2.50	5.90	1.55	1.75	11.50	6.70	1.45	1.75	13.50
31	2.15	.....	2.95	.....	4.40	.....	1.25	4.90	.....	1.45	.....	14.50

SOUTHERN ATLANTIC COAST DRAINAGE.

STAUNTON RIVER AT RANDOLPH, VA.

This station, which was established August 27, 1900, by E. W. Myers, is about five-eighths of a mile southwest of Randolph station, on the line of the Southern Railway from Richmond to Danville. It is described in Water-Supply Paper No. 48, page 133. During 1901 the following measurements were made by E. W. Myers and others:

January 15: Gage height, 7.65 feet; discharge, 6,153 second-feet.
March 29: Gage height, 7.17 feet; discharge, 5,091 second-feet.
April 23: Gage height, 11.25 feet; discharge, 12,256 second-feet.
May 23: Gage height, 28.25 feet; discharge, 58,000 second-feet.
July 19: Gage height, 14.10 feet; discharge, 14,950 second-feet.
July 24: Gage height, 4.90 feet; discharge, 3,896 second-feet.

Daily gage height, in feet, of Staunton River at Randolph, Va., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.95	3.55	2.90	4.60	4.90	6.30	5.50	3.40	6.10	5.90	3.35	3.40
2	3.75	3.30	2.85	4.50	4.70	5.70	5.15	3.35	6.00	5.20	3.35	3.40
3	3.40	3.40	2.85	19.00	4.50	5.20	5.00	3.25	5.40	4.70	3.35	4.20
4	3.20	4.30	2.85	22.60	4.35	5.00	4.20	3.10	5.10	4.30	3.35	6.10
5	3.00	4.70	2.80	13.00	4.15	4.90	3.80	3.70	4.80	4.00	3.35	6.20
6	3.10	4.30	2.80	8.50	4.10	4.70	4.80	14.40	4.70	3.90	3.30	4.90
7	3.10	3.80	2.75	7.40	4.00	5.30	5.50	22.60	4.50	3.75	3.30	4.00
8	3.10	3.70	2.70	6.30	4.10	6.20	4.30	24.80	4.40	3.75	3.30	3.80
9	3.05	4.15	2.90	5.60	5.00	5.70	4.30	11.30	4.30	3.70	3.30	3.70
10	3.05	4.40	3.65	5.10	6.00	5.10	3.90	6.80	4.10	3.65	3.30	3.90
11	4.00	4.30	4.10	4.70	6.70	4.30	3.30	6.60	4.00	3.65	3.30	4.50
12	19.40	4.00	8.00	4.40	5.55	4.10	3.20	8.10	4.00	3.65	3.30	4.30
13	22.30	3.75	6.00	4.35	4.55	3.80	4.20	13.60	3.90	7.50	3.40	4.00
14	10.40	3.50	4.80	9.20	4.00	4.00	6.30	8.70	3.90	6.40	3.35	3.80
15	7.10	3.40	4.25	12.60	3.80	3.95	19.20	22.00	3.80	4.80	3.30	9.00
16	6.00	3.55	3.85	9.20	3.65	3.90	18.70	24.00	3.70	4.00	3.30	19.50
17	5.60	3.40	3.60	6.70	3.60	10.00	9.90	8.00	5.20	3.70	3.25	10.00
18	5.15	3.40	3.40	5.80	3.80	8.50	8.20	14.60	7.70	3.60	3.30	6.80
19	4.60	3.35	3.30	5.30	3.75	6.50	14.15	11.60	7.40	3.50	3.30	5.50
20	4.05	3.30	3.20	9.80	4.10	5.60	11.40	9.10	5.30	3.50	3.30	5.10
21	4.00	3.10	3.55	19.60	5.50	5.60	7.50	7.60	4.50	3.45	3.25	4.60
22	3.95	2.95	4.75	19.75	22.00	6.70	6.10	6.10	4.20	3.45	3.25	4.30
23	4.00	2.95	4.05	11.30	28.20	5.40	5.40	6.60	3.90	3.45	3.90	4.40
24	3.90	2.80	3.55	8.70	22.00	5.20	4.85	8.70	3.90	3.40	5.20	4.50
25	4.00	2.80	3.60	7.80	9.80	5.90	4.50	10.10	3.80	3.35	6.20	5.20
26	3.90	2.90	7.70	6.85	9.10	5.00	4.20	9.40	3.70	3.35	4.70	6.20
27	3.60	2.95	13.50	6.30	9.65	8.30	4.15	19.00	3.50	3.35	4.00	8.70
28	3.55	3.00	9.60	5.80	12.80	6.20	4.60	20.00	3.10	3.35	3.60	8.90
29	3.50	.....	6.70	5.40	11.00	4.65	3.80	9.00	6.70	3.35	3.50	13.20
30	3.40	.....	5.50	5.10	8.30	6.15	3.60	7.70	7.30	3.35	3.40	32.00
31	3.55	.....	4.90	.....	7.00	.....	3.40	6.80	.....	3.35	.....	28.00

DAN RIVER AT SOUTH BOSTON, VA.

This station, which was established August 27, 1900, by E. W. Myers, is located in the town of South Boston, Va., on the railroad bridge of the Norfolk and Western Railroad. It is described in Water-Supply Paper No. 48, page 132. During 1901 the following measurements were made by E. W. Myers and others:

List of discharge measurements of Dan River at South Boston, Va.

Date.	Hydrographer.	Gage height.	Discharge.
1901.		*Feet.*	*Second-feet.*
January 15	Ernest Graves	5.79	4,447
March 28	E. W. Myers	11.50	11,490
April 22	N. C. Curtis	11.55	9,479
May 24	Ernest Graves	22.55	42,409
July 23	E. W. Myers	3.36	3,064
November 25	J. S. Henderson	4.70	4,086

Daily gage height, in feet, of Dan River at South Boston, Va., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4.60	3.00	2.20	4.50	3.50	4.00	2.80	3.60	5.20	5.10	2.50	2.60
2	4.00	3.30	2.20	4.50	3.30	3.80	2.80	2.90	5.00	4.90	2.50	2.60
3	3.00	3.30	2.20	18.35	3.30	3.60	3.00	2.70	4.20	4.80	2.50	3.00
4	2.40	3.20	2.20	21.75	3.20	3.80	2.90	2.40	4.10	4.40	2.50	4.10
5	2.40	3.20	2.20	14.40	3.20	3.50	2.80	2.65	3.80	4.10	2.50	4.70
6	2.40	3.10	2.30	.....	3.20	3.40	2.80	10.15	3.60	3.30	2.50	4.50
7	2.40	3.00	2.30	6.50	3.10	3.20	2.90	19.25	3.30	2.80	2.50	3.60
8	2.40	3.00	2.20	6.00	3.10	3.30	3.00	21.20	3.20	2.80	2.50	3.00
9	2.40	3.50	2.20	4.20	3.00	3.00	3.00	8.00	3.10	2.80	2.50	2.90
10	2.40	3.50	2.60	3.20	3.00	2.80	2.90	5.20	3.00	2.70	2.50	2.90
11	2.70	3.40	2.60	3.20	3.00	2.70	2.90	4.60	3.10	3.00	2.50	4.10
12	7.50	3.00	2.60	3.20	3.00	2.90	3.00	9.10	3.10	3.10	2.50	4.80
13	16.95	2.80	2.20	3.20	3.50	2.80	3.00	13.05	3.10	3.10	2.50	3.00
14	7.70	2.50	2.10	3.20	3.10	2.80	18.00	17.10	3.00	3.30	2.40	2.80
15	7.50	2.30	2.00	3.60	3.20	2.70	23.10	18.85	2.90	3.00	2.40	11.80
16	7.20	2.10	2.00	3.60	3.00	2.60	19.00	15.00	2.80	2.90	2.40	17.35
17	3.40	2.00	2.20	3.60	3.00	2.70	16.00	10.40	3.10	2.90	2.30	7.45
18	3.20	2.00	2.20	4.80	3.00	2.70	10.00	10.80	6.10	2.70	2.30	4.90
19	2.90	2.00	2.20	4.80	3.00	2.70	5.00	11.00	5.90	2.60	2.30	4.10
20	2.90	2.00	2.20	4.80	3.20	3.00	4.90	7.90	5.20	2.60	2.30	3.70
21	2.80	2.00	2.00	9.20	6.00	2.90	4.00	8.40	3.60	2.60	2.30	3.20
22	2.80	2.50	2.00	11.70	21.50	2.90	3.00	6.40	3.60	2.60	2.20	3.00
23	2.80	2.50	2.00	8.00	23.45	2.90	3.00	6.10	3.30	2.60	2.20	3.20
24	2.70	2.10	2.30	6.50	22.75	2.80	3.00	5.70	3.00	2.50	4.00	3.50
25	2.60	2.10	2.50	5.00	12.00	2.70	3.00	5.30	3.00	2.50	4.70	3.80
26	2.60	2.10	6.30	3.30	9.20	2.50	3.00	5.40	3.10	2.40	3.80	4.30
27	2.60	2.10	18.00	3.30	9.00	2.50	3.20	17.90	3.10	2.40	2.80	6.40
28	2.60	2.10	16.00	3.20	7.60	2.70	3.20	9.90	3.20	2.40	2.60	8.70
29	2.90	.....	6.50	3.10	6.00	2.80	2.90	6.45	3.20	2.40	2.60	10.90
30	3.20	.....	6.50	3.10	5.00	2.80	3.20	5.40	5.40	2.40	2.60	20.45
31	3.00	.....	5.20	.....	4.00	.....	3.80	4.85	.....	2.40	.....	24.85

ROANOKE RIVER AT ROANOKE, VA.

This station, which was established by D. C. Humphreys, July 11, 1896, is located at the edge of the city of Roanoke, on the Walnut street car line. It is described in Water-Supply Paper No. 48, page 130, and record of discharge measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 151. During 1901 the following measurements were made by D. C. Humphreys:

March 28: Gage height, 2.20 feet; discharge, 878 second-feet.
July 18: Gage height, 6.06 feet; discharge, 5,691 second-feet.

Daily gage height, in feet, of Roanoke River at Roanoke, Va., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.30	1.11	1.05	1.62	1.80	2.25	1.73	1.29	1.95	2.05	1.09	1.00
2	1.20	1.18	1.00	1.62	1.75	2.08	1.90	1.23	1.85	1.89	1.10	1.01
3	1.20	1.15	1.06	6.93	1.70	1.99	1.88	1.19	1.78	1.70	1.10	1.51
4	1.19	1.30	1.05	4.12	1.60	1.95	1.95	1.37	1.70	1.43	1.11	1.60
5	1.15	1.39	1.08	3.00	1.55	1.80	1.59	1.70	1.65	1.35	1.12	1.45
6	1.20	1.23	1.12	2.55	1.53	1.75	1.11	14.31	1.63	1.27	1.10	1.32
7	1.20	1.30	1.00	2.33	1.53	2.82	1.17	5.15	1.60	1.20	1.09	1.15
8	1.15	1.30	1.00	2.10	1.60	2.25	1.23	2.75	1.55	1.25	1.09	1.14
9	1.12	1.37	1.00	1.93	1.78	1.89	1.40	2.30	1.50	1.25	1.07	1.13
10	1.16	1.45	1.22	1.80	2.40	1.87	1.35	2.03	1.48	1.25	1.07	1.13
11	1.30	1.48	3.95	1.70	2.15	1.70	1.33	1.76	1.45	1.23	1.06	1.13
12	4.05	1.38	2.55	1.63	1.75	1.63	1.29	2.95	1.40	1.20	1.06	1.15
13	3.90	1.29	2.05	1.60	1.60	1.70	1.25	3.20	1.48	1.23	1.06	1.15
14	2.34	1.15	1.84	2.90	1.55	1.60	4.80	3.31	1.50	1.23	1.06	2.30
15	2.05	1.20	1.78	3.20	1.49	2.82	3.75	3.45	1.60	1.22	1.05	4.80
16	1.87	1.30	1.60	2.63	1.45	2.95	3.15	3.85	1.52	1.21	1.03	3.26
17	1.62	1.29	1.48	2.20	1.45	3.12	2.99	4.15	1.52	1.23	1.03	3.21
18	1.53	1.20	1.41	2.03	1.49	2.90	3.05	4.32	1.45	1.20	1.03	1.95
19	1.48	1.20	1.35	1.90	1.55	2.33	4.00	3.73	1.40	1.20	1.03	1.70
20	1.40	1.15	1.30	10.45	1.60	2.10	2.75	3.40	1.40	1.20	1.03	1.45
21	1.40	1.10	1.35	4.54	1.76	2.20	2.15	2.95	1.37	1.18	1.03	1.30
22	1.42	1.05	1.35	3.55	10.85	2.00	2.03	2.80	1.35	1.17	1.21	1.45
23	1.40	1.10	1.30	3.08	4.90	2.72	1.85	2.60	1.35	1.17	1.31	1.60
24	1.35	1.00	1.30	2.78	3.10	2.72	1.70	2.49	1.30	1.15	1.20	1.85
25	1.35	.88	1.30	2.58	3.00	2.35	1.65	2.21	1.27	1.12	1.15	2.10
26	1.28	1.20	1.73	2.40	3.40	2.07	1.59	2.25	1.25	1.10	1.08	2.20
27	1.31	1.07	3.21	2.20	4.61	2.03	1.55	2.23	1.30	1.10	1.03	2.25
28	1.25	1.06	2.53	2.05	4.40	1.90	1.49	2.21	2.10	1.09	1.01	2.15
29	1.05	.....	2.00	1.95	3.35	1.91	1.43	2.20	2.40	1.08	1.00	11.90
30	1.23	.....	1.79	1.85	2.40	1.75	1.36	2.20	2.10	1.09	1.00	7.25
31	1.20	.....	1.72	.....	2.49	.....	1.29	2.21	.....	1.09	.....	5.95

ROANOKE RIVER AT NEAL, N. C.

This station was described in Water-Supply Paper No. 48, page 131. The highest recorded water at this station occurred on May 26, 1901, the gage height being 30.30 feet, and the probable discharge being 84,200 second-feet. The lowest recorded stage of flow was from September 19 to 22, 1897, when the gage read 0.00, and the discharge was probably 2,000 second-feet. Results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 152. During 1901 the following discharge measurements were made by E. W. Myers, and others:

April 3: Gage height, 19.90 feet; discharge, 24,004 second-feet.
April 4: Gage height, 21.80 feet; discharge, 28,875 second-feet.
July 17: Gage height, 22.90 feet; discharge, 35,400 second-feet.
November 30: Gage height, 5.60 feet; discharge, 5,558 second-feet.

Daily gage height, in feet, of Roanoke River at Neal, N. C., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	6.60	5.80	3.55	19.50	11.40	21.30	10.40	5.70	22.10	10.50	4.40	5.20
2	7.50	5.60	3.80	16.30	10.20	18.80	8.70	5.50	19.50	12.20	4.45	4.80
3	7.90	5.50	3.80	19.00	9.20	16.70	10.70	5.50	17.40	13.00	4.40	4.60
4	7.70	5.40	3.60	22.65	8.30	14.40	9.80	5.20	15.50	13.50	4.40	4.90
5	6.70	5.20	3.45	24.45	7.40	12.70	9.20	4.70	13.50	11.90	4.40	6.10
6	6.00	5.60	3.40	26.25	6.80	11.30	7.70	4.30	11.70	9.70	4.40	8.60
7	5.20	5.80	3.35	26.45	6.30	10.10	6.10	5.80	10.40	8.10	4.40	9.60
8	4.70	7.10	3.40	25.90	5.50	9.50	5.70	17.40	9.10	7.00	4.30	8.30
9	4.40	6.60	3.40	23.40	5.90	8.90	7.10	23.05	8.30	6.30	4.35	7.00
10	4.30	6.20	3.20	20.40	6.50	8.60	8.70	25.15	7.60	5.90	4.40	6.20
11	4.30	7.10	3.30	17.60	11.40	9.40	8.50	26.30	7.00	5.70	4.30	5.80
12	4.40	8.35	3.80	15.40	16.40	8.10	8.00	25.10	6.60	5.50	4.25	5.80
13	5.75	8.50	5.60	12.70	15.70	7.00	6.90	23.35	6.20	5.40	4.25	5.80
14	21.58	7.70	6.40	11.60	13.20	6.25	6.10	23.20	6.00	6.50	4.30	6.10
15	22.65	6.90	8.85	12.60	10.30	5.80	8.80	23.80	6.00	8.60	4.30	7.30
16	22.70	6.20	8.90	18.25	8.50	5.75	17.10	24.85	5.80	8.45	4.30	13.10
17	20.16	5.70	6.60	19.30	7.10	6.20	22.80	26.00	5.60	8.20	4.30	21.70
18	17.30	5.20	5.65	17.80	6.10	12.40	24.65	26.37	6.40	7.60	4.15	22.40
19	15.20	4.95	4.95	15.20	5.40	15.50	25.80	26.73	14.20	6.50	4.00	22.10
20	13.40	4.80	4.40	13.10	5.50	15.60	24.80	26.25	19.20	5.80	4.00	19.20
21	11.70	4.60	4.40	11.60	7.00	13.20	23.95	25.10	18.50	5.30	4.00	15.90
22	9.90	4.50	4.80	16.50	9.70	10.70	22.90	23.70	15.80	5.10	4.00	13.30
23	8.50	4.40	4.70	20.50	20.30	12.00	20.45	22.15	13.10	4.90	4.00	9.80
24	7.50	4.20	4.90	23.15	23.25	11.90	17.60	20.10	10.70	4.80	4.70	8.80
25	6.90	3.90	5.60	23.00	26.10	10.40	15.10	18.30	8.80	4.70	5.60	8.80
26	6.50	3.70	6.10	21.30	30.30	10.50	13.00	19.10	7.60	4.60	7.60	10.60
27	6.15	3.50	19.95	19.00	29.25	9.50	11.10	19.35	6.60	4.50	9.10	12.70
28	6.00	3.80	22.50	16.70	27.27	8.60	9.30	19.80	6.20	4.50	8.30	20.85
29	5.60	.....	23.70	14.10	25.35	12.30	7.90	22.55	6.30	4.40	6.70	23.50
30	5.20	.....	24.10	12.90	24.15	12.90	7.20	23.67	8.00	4.30	5.60	26.05
31	5.20	.....	22.65	.....	23.00	.....	6.40	23.60	.....	4.30	.....	25.90

DEEP RIVER AT CUMNOCK, N. C.

This station was established June 29, 1900, by E. W. Myers. It is described in Water-Supply Paper No. 48, page 136. The observer is J. A. McIver, a watchman at Cumnock. During 1901 the following measurements were made by E. W. Myers and others:

March 27: Gage height, 30.50 feet; discharge, 22,425 second-feet.
April 6: Gage height, 5.60 feet; discharge, 1,671 second-feet.
July 15: Gage height, 18.25 feet; discharge, 12,013 second-feet.
November 28: Gage height, 2.24 feet; discharge, 204 second-feet.

Daily gage height, in feet, of Deep River at Cumnock, N. C., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	6.75	3.35	2.00	13.23	1.73	4.59	6.04	2.65	7.05	2.66	2.58	2.20
2	4.84	3.07	1.97	14.80	1.59	3.79	4.87	2.52	7.21	2.61	2.12	2.18
3	3.90	3.18	1.91	12.06	1.15	3.80	3.32	2.31	4.70	2.53	2.09	2.25
4	2.92	6.96	1.87	9.51	1.11	3.89	3.21	2.53	4.20	3.06	2.06	2.27
5	2.48	5.71	1.82	7.52	1.11	3.94	3.15	3.07	4.01	2.94	2.03	2.24
6	2.04	4.75	1.91	4.82	1.11	3.59	3.09	5.33	3.85	2.68	2.00	2.20
7	2.90	3.25	1.90	2.67	1.14	2.81	3.86	13.33	3.49	2.67	1.99	2.18
8	2.51	2.92	1.90	2.20	1.05	2.75	3.71	20.02	2.56	2.57	2.06	2.13
9	2.08	4.27	1.88	1.96	1.02	2.58	5.48	18.03	2.49	2.51	2.13	2.12
10	2.02	4.71	1.93	1.74	2.00	2.49	7.25	14.84	2.41	2.49	2.11	2.10
11	1.98	4.90	2.38	1.56	2.96	2.34	4.43	10.56	2.35	2.46	2.09	2.09
12	2.18	3.97	2.73	1.27	2.68	2.44	2.76	6.11	2.27	2.40	2.19	2.09
13	9.55	3.45	2.75	1.17	2.34	2.72	2.94	7.86	2.21	4.62	2.21	2.12
14	5.08	3.06	2.45	8.98	2.25	3.43	14.25	8.42	2.83	4.57	2.19	2.22
15	3.27	2.91	2.40	6.35	2.15	3.83	20.04	11.38	3.17	3.64	2.11	8.03
16	2.41	2.66	2.20	4.37	1.69	11.32	11.25	13.84	3.33	2.80	2.09	6.61
17	5.70	2.47	2.11	3.39	1.18	15.73	8.52	11.45	3.62	2.67	2.08	4.08
18	7.03	2.37	2.06	2.13	1.16	13.05	6.11	10.53	12.18	2.60	2.06	3.25
19	4.96	2.27	1.75	2.08	1.96	9.04	16.13	10.27	14.41	2.55	2.03	3.23
20	3.12	2.20	1.69	2.56	2.01	4.67	17.44	8.97	16.62	2.49	2.01	3.26
21	2.75	2.24	1.99	10.65	2.37	3.55	7.15	7.85	11.14	2.45	1.99	3.22
22	2.70	2.20	1.93	8.89	11.99	3.43	3.99	7.12	6.25	2.41	2.15	3.18
23	2.48	2.05	1.91	5.03	(a)	3.75	3.72	6.44	4.64	2.38	2.21	3.00
24	2.41	2.11	1.86	4.97	(a)	4.15	3.54	9.24	3.58	2.36	2.35	3.38
25	2.62	2.18	10.65	4.65	(a)	5.89	3.32	10.70	3.33	2.34	2.35	3.68
26	2.33	2.59	36.03	2.65	7.70	10.94	2.82	5.44	3.16	2.33	2.31	5.18
27	2.29	2.39	29.60	1.97	4.66	13.64	2.71	7.91	2.97	2.33	2.27	5.40
28	2.09	2.27	26.51	1.91	7.76	8.67	2.53	8.50	2.92	2.30	2.24	7.06
29	2.20	.....	20.75	1.88	8.13	4.58	2.49	6.26	2.90	2.33	2.22	13.09
30	2.30	.....	16.83	1.83	6.83	4.37	2.35	4.63	2.74	2.39	2.21	16.60
31	3.77	.....	10.67	.....	6.51	.....	2.29	3.46	.....	2.52	.....	23.76

[a] Flood.

CAPE FEAR RIVER AT FAYETTEVILLE, N. C.

This station was described in Water-Supply Paper No 48, page 137. The maximum flood of which there is any record occurred on May 24, 1901, when the river reached a height of 58.50. The lowest stage of flow was on October 8 and 9, 1897, when the gage height was 0.2 foot and the discharge 340 second-feet. The drainage area above the station is 4,493 square miles.

Records of flow during 1900 will be found in the Twenty-second Annual Report, Part IV, page 155. During 1901 the following measurements were made by E. W. Myers and others:

April 5: Gage height, 47.6 feet; discharge, 46,519 second-feet.
July 15: Gage height, 40.3 feet; discharge, 38,300 second-feet.
November 29: Gage height, 4.50 feet; discharge, 1,783 second-feet.

Daily gage height, in feet, of Cape Fear River at Fayetteville, N. C., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	12.00	6.40	4.20	12.80	5.20	13.30	9.20	4.70	11.00	10.40	3.60	3.80
2	11.40	6.40	4.00	9.60	4.80	10.00	10.00	4.90	13.60	9.30	3.80	3.70
3	10.00	5.50	3.90	14.40	4.50	9.00	9.50	4.20	12.40	10.00	3.80	3.60
4	8.20	5.60	3.70	45.90	4.50	7.80	7.00	4.00	9.80	9.40	3.60	4.00
5	6.00	9.00	3.70	47.70	4.30	6.30	5.50	3.60	7.60	8.50	3.60	4.00
6	5.70	11.00	3.70	11.70	4.00	6.30	4.60	6.00	6.50	7.50	3.60	3.80
7	5.20	8.20	3.30	30.80	3.90	6.00	3.80	29.40	5.80	6.30	3.70	4.10
8	4.60	6.40	3.10	23.80	4.00	5.90	4.10	43.60	5.50	5.90	3.70	4.00
9	4.00	6.00	3.10	16.60	5.00	5.60	6.00	44.80	5.30	5.30	3.70	3.80
10	4.20	10.00	3.00	10.00	5.50	5.40	10.20	38.00	5.00	5.20	3.70	3.90
11	4.50	11.20	3.50	7.00	7.70	5.00	10.00	30.70	4.70	5.20	3.50	3.80
12	4.80	9.30	4.30	6.60	10.50	4.80	8.70	19.80	4.70	5.00	3.50	4.00
13	12.90	10.00	5.30	6.00	10.00	4.40	7.00	11.00	4.40	4.80	3.50	3.90
14	15.40	9.50	5.00	7.00	8.30	6.30	8.00	28.80	4.30	5.00	3.60	4.00
15	11.00	7.40	4.50	20.40	7.00	9.40	30.10	42.00	4.10	9.00	3.60	5.00
16	8.40	6.60	4.00	20.80	5.80	9.60	41.50	40.00	4.00	8.00	3.60	15.40
17	6.70	5.40	3.70	16.00	4.70	14.40	36.50	32.00	7.80	6.20	3.60	16.20
18	9.00	5.00	3.40	11.80	4.40	22.30	29.70	30.00	14.00	5.50	3.50	11.00
19	12.20	5.00	3.20	9.30	5.00	23.00	25.30	26.50	37.50	5.00	3.60	9.20
20	10.00	4.80	3.10	7.50	6.60	15.70	31.10	26.60	43.60	4.50	3.50	7.00
21	8.50	4.50	4.00	8.30	10.00	11.40	33.00	23.80	40.00	4.40	3.50	5.20
22	6.00	4.40	4.50	13.20	14.00	9.00	25.80	20.40	29.00	4.10	3.50	4.60
23	5.20	4.00	4.00	14.00	48.10	13.40	18.20	15.60	21.80	3.80	3.50	4.20
24	4.60	4.00	3.90	12.00	58.50	10.80	12.00	13.40	15.00	4.00	3.70	4.60
25	5.30	4.10	3.80	14.00	54.70	9.00	10.30	20.00	10.40	3.90	6.00	5.60
26	5.30	4.00	5.50	12.00	42.00	8.70	9.00	23.00	8.30	3.80	6.10	7.00
27	5.40	4.00	28.30	9.60	33.90	7.80	6.80	17.80	7.20	4.00	5.00	7.30
28	5.20	3.90	36.00	8.00	27.50	9.20	5.60	15.60	7.30	3.80	4.70	12.00
29	4.60	.....	32.00	7.00	27.20	16.60	5.40	16.40	9.00	3.60	4.50	16.00
30	4.60	.....	25.80	6.10	23.00	11.20	5.00	16.60	10.00	3.60	3.80	25.20
31	5.00	.....	19.70	.....	18.00	.....	4.60	12.50	.....	3.50	.....	35.50

YADKIN RIVER AT SILOAM, N. C.

This station was established August 2, 1900, and is described in Water-Supply Paper No. 48, page 158. On April 5, 1901, a measurement was made by N. C. Curtis, when the gage height was 5.00 feet, and the discharge 5,237 second-feet.

Daily gage height, in feet, of Yadkin River, at Siloam, N. C., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.70	2.80	2.60	2.80	3.50	3.60	7.60	3.60	3.70	3.60	3.60	3.60
2	2.70	2.80	2.60	2.80	3.50	3.50	7.60	3.70	3.60	3.60	3.60	3.60
3	2.80	2.80	2.60	2.70	3.60	3.50	3.70	3.70	3.60	3.60	3.60	3.60
4	2.70	2.80	2.60	2.70	3.60	3.50	3.70	3.60	3.60	3.60	3.60	3.90
5	2.70	2.80	2.80	2.80	3.50	3.60	4.10	3.60	3.70	3.60	3.60	3.80
6	2.80	2.80	2.70	2.80	3.50	3.60	4.80	3.60	3.70	3.60	3.60	3.60
7	2.80	2.90	2.70	2.80	3.50	3.50	3.60	3.70	3.60	3.70	3.60	3.60
8	2.70	2.80	2.70	2.80	2.60	3.50	3.70	3.70	3.60	3.70	3.60	3.60
9	2.70	2.90	2.90	2.70	3.50	3.60	3.70	3.60	3.60	3.60	3.60	3.60
10	2.90	2.90	3.10	2.70	3.50	3.60	3.70	3.60	3.60	3.60	3.60	3.60
11	3.20	2.80	3.00	2.80	3.60	3.70	3.70	5.30	3.60	3.60	3.60	3.60
12	4.10	2.80	3.00	2.80	3.60	3.70	3.70	6.40	3.60	3.70	3.60	3.60
13	3.20	2.80	2.80	2.90	3.60	3.60	3.90	11.20	3.60	3.80	3.60	3.60
14	3.00	2.80	2.80	2.90	3.60	3.90	6.80	10.50	3.70	3.60	3.70	3.90
15	2.80	2.80	2.70	2.80	3.50	10.70	5.10	10.80	3.60	3.60	3.60	11.60
16	2.80	2.80	2.70	2.80	3.50	10.90	3.60	10.30	3.60	3.60	3.60	8.30
17	2.80	2.80	2.70	2.80	3.60	10.80	3.60	11.60	3.60	3.60	3.60	7.20
18	2.80	2.80	2.70	2.80	4.00	10.30	4.30	9.30	3.60	3.60	3.60	3.80
19	2.80	2.70	2.70	3.20	3.90	7.40	3.70	4.10	3.60	3.60	3.60	3.70
20	2.80	2.70	2.70	.....	3.90	7.60	3.70	3.60	3.60	3.60	3.60	3.60
21	2.80	2.70	2.80	.....	4.30	9.30	3.60	3.60	3.70	3.60	3.60	3.60
22	2.90	2.80	2.80	.....	(a)	9.40	3.60	3.70	3.70	3.60	3.60	3.60
23	2.90	2.80	2.70	.....	(a)	8.60	3.60	6.30	3.60	3.60	3.70	3.60
24	2.80	2.80	2.70	.....	5.00	7.80	3.60	.....	3.60	3.60	3.60	3.60
25	2.80	2.70	2.80	.....	4.50	7.40	3.70	6.40	3.60	3.60	3.60	3.60
26	2.70	2.70	10.40	.....	4.60	3.80	3.60	3.70	3.60	3.60	3.60	3.60
27	2.70	2.60	8.60	.....	4.60	3.80	3.70	3.70	3.70	3.60	3.60	3.70
28	2.70	2.60	3.20	.....	4.10	4.20	3.60	3.60	3.70	3.60	3.60	4.30
29	2.70	.....	6.30	.....	3.50	7.40	3.70	3.60	3.80	3.60	3.60	11.80
30	2.80	.....	2.90	3.50	3.50	8.90	3.70	3.60	3.70	3.60	3.60	9.20
31	2.80	.....	2.80	.....	3.60	.....	3.60	3.80	.....	3.60	.....	7.40

a Too high to measure.

YADKIN RIVER AT SALISBURY, N. C.

This station is described in Water-Supply Paper No. 48, page 139. The lowest recorded flow was 900 second-feet, occurring in September and October, 1897. The highest flood of which there is any record occurred on March 20, 1899, the gage height being 18.80 feet, and the measured discharge 115,000 second-feet. Results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 156. During 1901 the following measurements were made by E. W. Myers and others:

April 3: Gage height, 10.50 feet; discharge, 38,550 second-feet.
April 6: Gage height, 4.72 feet; discharge, 12,160 second-feet.
April 24: Gage height, 4.48 feet; discharge, 9,611 second-feet.
July 27: Gage height, 2.80 feet; discharge, 4,509 second-feet.
November 14: Gage height, 2.60 feet; discharge, 3.288 second-feet.

Daily gage height, in feet, of Yadkin River at Salisbury, N. C., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.45	2.50	2.35	3.70	3.20	3.60	5.20	2.95	4.55	5.20	2.70	2.60
2	3.05	2.50	2.35	3.25	3.15	3.50	4.85	2.82	4.70	4.00	2.70	2.60
3	2.80	2.45	2.35	10.00	3.10	3.40	3.60	2.75	3.95	3.85	2.65	2.55
4	2.65	3.15	2.45	10.85	3.05	3.25	3.40	2.65	3.70	3.45	2.70	2.95
5	2.50	3.35	2.40	6.70	3.00	3.30	3.25	2.70	3.50	3.20	2.70	3.10
6	2.50	3.05	2.35	4.40	3.00	8.10	3.15	5.77	3.40	3.05	2.70	2.75
7	2.50	2.72	2.35	3.80	2.90	3.60	3.40	11.38	3.25	3.00	2.65	2.60
8	2.50	2.50	2.35	3.50	3.05	3.85	4.35	9.92	3.25	2.95	2.60	2.60
9	2.50	2.65	2.35	3.25	3.45	3.40	4.60	4.80	3.20	2.95	2.60	2.65
10	2.45	3.00	2.40	3.05	3.60	3.15	4.22	3.80	3.15	2.90	2.65	2.60
11	3.10	2.85	2.60	3.00	4.00	3.10	3.40	3.50	3.15	2.85	2.60	2.90
12	5.30	2.75	4.00	2.85	3.65	3.00	3.15	3.95	3.30	2.85	2.60	2.85
13	8.23	2.70	3.10	2.80	3.20	2.90	3.00	5.32	3.10	2.90	2.60	2.75
14	4.83	2.60	2.70	3.30	2.95	2.95	3.35	9.28	3.10	4.00	2.65	2.75
15	3.80	2.56	2.60	4.60	2.85	5.85	8.08	10.45	3.00	3.30	2.60	6.17
16	3.35	2.55	2.45	3.65	2.75	8.80	6.95	9.82	3.00	3.00	2.60	8.58
17	3.05	2.55	2.45	3.25	2.95	9.00	5.15	7.75	3.35	2.85	2.60	5.10
18	3.00	2.55	2.45	3.05	3.60	7.57	4.45	7.70	3.85	2.80	2.60	3.90
19	2.80	2.50	2.40	3.00	2.90	4.40	5.28	6.20	4.60	2.80	2.50	3.35
20	2.70	2.50	2.40	7.50	3.30	4.78	5.05	5.40	3.60	2.80	2.55	3.10
21	2.70	2.45	2.40	15.90	3.45	4.50	3.75	4.75	3.20	2.80	3.50	2.90
22	2.60	2.40	2.45	11.25	9.52	4.45	3.55	4.25	3.05	2.75	2.55	2.75
23	2.60	2.40	2.50	5.22	14.83	6.25	3.20	4.55	3.00	2.75	2.55	2.50
24	2.60	2.40	2.40	4.53	10.50	6.65	3.00	6.60	2.95	2.70	3.00	2.90
25	2.60	2.40	2.40	4.07	5.15	5.15	2.90	5.87	2.90	2.70	3.40	3.20
26	2.55	2.30	6.65	3.80	4.20	4.68	2.85	6.15	2.85	2.70	2.85	3.20
27	2.50	2.45	9.92	3.60	4.80	4.60	2.80	6.15	2.85	2.70	2.65	3.40
28	2.50	2.40	7.58	3.50	6.33	4.25	2.85	5.53	2.90	2.70	2.60	4.25
29	2.45	.....	4.60	3.35	5.33	3.55	2.90	5.87	4.50	2.65	2.60	8.20
30	2.45	.....	3.60	3.25	4.35	5.00	2.70	6.10	5.80	2.70	2.60	15.72
31	2.50	.....	3.60	.....	3.90	.....	2.75	4.70	.....	2.70	.....	17.97

CATAWBA RIVER NEAR MORGANTON, N. C.

This station was established in the summer of 1900, during the investigation of the Southern Appalachian region. It is described in Water-Supply Paper No. 48, page 140. A measurement was made by N. C. Curtis, March 28, when the gage height was 3.25 feet and the discharge 4,025 second-feet. No gage heights were kept during the year 1901, and in May of that year the bridge was carried away by flood.

JOHN RIVER NEAR MORGANTON, N. C.

This station was established June 17, 1900, and is described in Water-Supply Paper No. 48, page 142. A measurement was made March 28, 1901, by N. C. Curtis, when the gage height was 4.07 feet and the discharge 1,075 second-feet.

Daily gage height, in feet, of John River, near Morganton, N. C., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.62	2.23	2.20	3.05	2.95	3.63	3.45	2.60	5.15	3.08	2.52	2.35
2	2.52	2.28	2.15	8.85	2.90	.....	3.30	2.50	4.05	3.00	2.53	2.40
3	2.42	.....	.....	8.20	2.90	3.42	3.15	2.40	3.90	2.90	2.53	2.43
4	2.32	2.65	2.15	4.15	2.80	3.33	3.10	.....	3.80	2.80	2.53	2.43
5	2.30	2.33	2.13	3.90	.....	3.25	3.00	2.60	3.60	2.75	2.53	2.33
6	.....	2.33	2.13	3.25	2.80	3.50	3.00	17.02	3.50	.....	2.53	2.33
7	2.32	2.33	2.13	.....	2.73	3.70	.....	6.00	3.40	2.70	2.53	2.33
8	2.32	2.28	2.13	3.18	3.85	3.45	3.00	3.85	3.20	2.73	2.53	2.35
9	2.32	2.53	2.08	2.95	3.05	.....	3.00	3.38	3.20	2.72	2.53	2.40
10	2.37	.....	.....	2.70	3.08	3.13	2.93	3.05	3.20	2.70	2.53	3.50
11	2.80	2.43	3.25	2.68	3.05	3.08	2.90	.....	3.17	2.70	2.53	3.10
12	5.65	2.43	2.45	2.60	.....	3.00	2.95	3.27	3.17	2.68	2.50	2.90
13	.....	2.38	2.33	2.70	2.78	2.90	3.00	4.35	3.10	2.70	2.53	2.80
14	3.02	2.33	2.30	.....	2.70	8.95	.....	6.10	3.08	2.95	2.50	3.10
15	2.88	2.35	2.28	2.85	2.70	4.60	2.95	10.30	.....	2.80	2.50	19.00
16	2.68	2.35	2.25	2.68	2.63	.....	3.25	5.75	3.60	2.78	2.45	6.58
17	2.58	.....	.....	2.60	2.57	5.55	3.05	5.00	3.15	2.72	.....	4.70
18	2.50	2.30	2.23	2.70	2.50	4.35	2.90	.....	3.10	2.68	2.48	3.75
19	2.48	2.33	2.20	5.20	.....	3.92	3.15	5.15	3.00	2.65	2.47	3.05
20	.....	2.28	2.20	17.70	3.18	4.45	3.05	4.48	3.00	.....	2.48	2.95
21	2.43	2.28	2.72	6.60	10.25	4.27	.....	4.50	2.95	2.60	2.42	2.87
22	2.43	2.28	2.32	4.60	20.50	7.90	2.77	7.15	.....	2.60	2.43	.....
23	2.40	2.23	2.25	4.15	6.15	.....	2.70	6.11	2.90	2.60	2.47	2.90
24	2.33	.....	.....	3.70	4.80	4.70	2.70	4.40	2.87	2.55	.....	2.90
25	2.33	2.20	2.90	3.53	4.40	4.15	2.63	.....	2.88	2.55	2.50	3.00
26	2.30	2.23	13.60	3.38	.....	3.80	2.60	4.55	2.80	2.50	2.43	3.42
27	.....	2.23	6.15	3.27	6.55	3.65	2.57	4.60	2.70	.....	2.42	2.90
28	2.28	2.23	4.05	.....	5.00	3.60	.....	4.48	3.60	2.53	2.35	2.85
29	2.28	.....	3.35	3.08	4.20	3.50	2.60	4.43	3.10	2.50	2.38	15.00
30	2.33	.....	3.75	3.00	3.90	.....	8.60	6.15	3.15	2.55	2.30	9.00
31	2.33	.....	.....	.....	3.75	.....	2.73	5.90	.....	2.50	.....	6.45

CATAWBA RIVER AT CATAWBA, N. C.

This station was established in July, 1896, but was abandoned December 31, 1899. On June 13, 1900, it was reestablished as a temporary station to assist in the study of the hydrography of the Southern Appalachian region. It is described in Water-Supply Paper No. 48, page 143. During 1901 the following measurements were made by E. W. Myers:

March 29: Gage height, 5.83 feet; discharge, 5,640 second-feet.
April 27: Gage height, 4.37 feet; discharge, 4,354 second-feet.
July 25: Gage height, 2.95 feet; discharge, 2,805 second-feet.
November 15: Gage height, 2.20 feet, discharge, 2,398 second-feet.

Daily gage height, in feet, of Catawba River at Catawba, N. C., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	5.40	2.80	3.00	5.50	3.90	4.40	2.95	2.60	6.30	4.20	2.35	2.10
2	3.35	2.85	2.98	8.50	3.85	3.30	2.55	2.55	5.20	3.50	2.35	2.20
3	3.25	2.90	2.98	15.10	3.75	3.60	2.40	2.50	4.40	3.20	2.35	2.70
4	3.10	4.25	2.98	9.80	3.60	3.40	2.30	2.50	4.15	3.10	2.35	2.80
5	3.00	3.40	2.98	6.00	3.50	3.35	2.30	3.30	4.00	2.95	2.50	2.30
6	2.95	3.20	2.95	5.10	3.45	5.50	2.30	18.00	3.60	2.70	2.50	2.20
7	2.90	3.00	2.95	4.80	3.35	4.50	3.00	10.63	3.40	2.60	2.50	2.20
8	2.90	3.15	2.95	4.50	3.40	4.15	4.65	5.35	3.30	2.55	2.50	2.20
9	2.85	3.20	2.95	4.40	3.30	3.20	3.60	4.00	3.25	2.45	2.50	2.20
10	3.00	3.35	3.00	4.30	3.95	3.13	3.00	4.25	3.20	2.40	2.30	2.20
11	3.25	3.20	4.80	4.00	3.70	3.00	3.05	3.80	3.20	2.40	2.20	2.20
12	11.55	3.20	4.10	4.00	3.55	2.98	3.00	4.00	3.05	2.40	2.30	2.20
13	7.55	3.15	3.50	4.20	3.45	2.90	3.00	6.45	3.00	4.50	2.35	2.20
14	5.35	3.15	3.35	6.40	3.30	13.80	3.25	15.60	3.00	2.75	2.20	2.50
15	4.10	3.15	3.25	5.00	3.25	10.00	5.10	16.00	3.00	2.45	2.20	16.80
16	3.65	3.10	3.10	5.00	3.30	8.50	3.80	11.10	3.00	2.40	2.20	6.00
17	3.40	3.10	3.05	4.60	3.35	7.30	3.55	10.70	5.50	2.40	2.15	4.50
18	3.30	3.05	3.00	4.25	3.25	6.70	3.40	8.80	4.80	2.40	2.15	3.90
19	3.30	3.00	3.10	7.25	4.20	5.70	3.10	6.50	3.30	2.40	2.25	3.70
20	3.20	3.00	3.05	24.90	8.65	5.15	6.25	6.00	3.00	2.40	2.25	3.20
21	3.00	3.00	3.00	([a])	15.80	5.00	4.25	5.60	3.00	2.40	2.20	2.80
22	3.00	2.95	3.00	.....	28.50	5.00	3.70	9.00	2.80	2.40	2.20	2.70
23	2.95	2.95	3.00	.....	10.70	6.30	3.40	12.80	2.75	2.40	3.60	2.70
24	2.95	3.00	3.00	.....	6.35	4.05	3.10	8.80	2.70	2.40	2.70	2.70
25	2.90	3.00	6.70	.....	5.40	3.50	2.95	6.50	2.70	2.40	2.40	2.65
26	2.85	2.95	17.50	4.60	5.60	3.55	2.65	5.75	2.60	2.35	2.25	2.60
27	2.80	2.95	10.85	4.37	8.70	3.25	3.25	9.10	2.55	2.35	2.25	3.80
28	2.80	2.98	7.05	4.20	7.50	3.50	4.50	5.25	3.10	2.35	2.15	4.00
29	2.80	.....	5.80	4.00	5.70	3.40	6.35	9.80	4.00	2.35	2.10	19.50
30	2.80	.....	5.20	3.80	5.85	3.40	3.25	7.60	4.80	2.35	2.00	11.10
31	2.80	.....	5.60	.....	5.35	.....	2.80	6.65	.....	2.35	.....	6.50

[a] Gage wire broken from April 21-26.

CATAWBA RIVER NEAR ROCKHILL, S. C.

This station, which is described in Water-Supply Paper No. 48, page 144, was established September 3, 1895. The maximum flood of which there is any record at this station occurred May 23, 1901, the water reaching a height of 24.15 feet on the gage. A gaging was made shortly before and after the extreme flood height, the average height during the period being 24.10 feet and the measured discharge 150,783 second-feet from an area of 2,987 square miles, the discharge being therefore at the rate of about 50.5 second-feet per square mile. Results of measurements for 1900 are given in the Twenty-second Annual Report, Part IV, page 157. During the year 1901 the following measurements were made by E. W. Myers and others:

April 4: Gage height, 9.80 feet; discharge, 33,150 second-feet.
April 23: Gage height, 4.65 feet; discharge, 10,314 second-feet.
May 23: Gage height, 24.15 feet; discharge, 150,783 second-feet.
July 20: Gage height, 2.00 feet; discharge, 3,822 second-feet.
November 17: Gage height, 2.10 feet; discharge, 4,299 second-feet.

Daily gage height, in feet, of Catawba River near Rockhill, S. C., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.70	2.00	1.90	3.10	2.90	3.50	4.90	2.30	5.55	4.10	2.20	2.00
2	2.80	2.00	1.90	6.55	2.90	3.30	4.00	2.20	5.20	3.90	2.20	2.00
3	2.70	2.00	1.90	11.80	2.80	3.10	3.50	2.20	4.10	3.80	2.20	2.00
4	2.40	3.80	1.90	12.90	2.70	3.00	3.30	2.10	3.70	3.50	2.20	2.30
5	2.40	2.80	1.90	6.90	2.70	3.00	2.70	2.00	3.50	2.80	2.20	2.50
6	2.20	2.70	1.90	4.10	2.60	3.00	2.50	8.80	3.20	2.60	2.20	2.30
7	2.10	2.40	1.90	3.90	2.60	3.90	2.30	12.35	3.10	2.60	2.25	2.15
8	2.10	2.20	1.80	3.10	2.50	3.50	3.50	12.90	3.00	2.60	2.20	2.00
9	2.10	2.20	1.80	3.00	2.70	3.00	7.20	4.00	3.00	2.50	2.20	2.10
10	2.00	2.40	1.80	2.70	2.90	2.50	5.00	3.00	2.90	2.40	2.15	2.10
11	2.20	2.30	2.00	2.60	2.70	2.50	3.50	2.70	2.90	2.40	2.15	2.20
12	3.00	2.30	2.30	2.50	2.70	2.50	2.80	2.60	2.80	2.40	2.15	2.50
13	8.50	2.30	2.80	2.50	2.60	2.50	2.40	2.80	2.80	2.40	2.20	2.30
14	4.10	2.30	2.40	3.50	2.50	2.50	2.30	7.40	2.80	2.50	2.20	2.40
15	3.40	2.20	2.20	4.00	2.50	6.70	3.30	14.30	2.80	3.10	2.20	5.20
16	2.70	2.20	2.10	3.50	2.40	9.20	3.50	14.50	2.80	3.00	2.20	14.40
17	2.50	2.20	2.00	2.90	2.40	7.00	3.40	12.00	4.30	2.90	2.10	5.00
18	2.50	2.20	2.00	2.70	2.40	6.00	2.80	9.50	4.50	2.40	2.10	3.50
19	2.40	2.20	2.00	2.60	2.20	4.70	3.50	7.20	5.90	2.30	2.10	3.00
20	2.30	2.10	2.00	10.50	2.80	4.50	3.20	6.00	4.30	2.30	2.10	2.80
21	2.20	2.10	2.00	19.65	3.00	4.50	2.70	4.60	3.00	2.30	2.10	2.60
22	2.20	2.00	1.90	12.20	15.30	5.00	2.30	5.30	2.90	2.20	2.10	2.60
23	2.20	2.00	1.90	5.00	21.80	4.70	2.20	7.00	2.70	2.20	2.10	2.60
24	2.10	1.90	1.90	4.20	15.40	6.50	2.20	9.90	2.60	2.20	2.40	2.60
25	2.10	1.90	1.90	3.80	5.30	4.30	2.10	7.10	2.60	2.20	2.45	2.70
26	2.10	1.90	4.10	3.50	4.60	3.80	2.00	5.50	2.60	2.20	2.30	2.70
27	2.00	1.90	13.60	3.30	7.90	3.30	2.00	8.50	2.60	2.20	2.30	3.70
28	2.00	1.90	10.50	3.10	8.50	3.60	2.30	5.80	2.60	2.20	2.10	3.20
29	2.00	.....	4.50	3.00	5.80	3.10	2.10	5.70	3.70	2.20	2.10	9.10
30	2.00	.....	4.00	2.90	4.50	3.50	2.00	9.50	5.40	2.20	2.10	18.65
31	2.00	.....	3.60	.....	3.80	.....	2.00	5.60	.....	2.20	.....	17.90

BROAD RIVER (OF THE CAROLINAS) AT DELLINGER, S. C.

This station was established August 30, 1900, and is described in Water-Supply Paper No. 48, page 145. No measurements of discharge were made during 1901.

Daily gage height, in feet, of Broad River (of the Carolinas), at Dellinger, S. C., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.25	1.20	0.90	2.50	2.40	2.00	3.20	1.40	5.75	3.80	2.60	1.90
2	1.60	1.20	.90	5.00	2.20	2.00	2.70	1.40	4.70	4.80	2.55	2.05
3	1.40	1.00	.70	11.35	2.20	2.00	2.20	1.40	4.20	3.70	2.30	2.20
4	1.30	3.00	.90	5.20	2.20	1.70	1.60	1.00	4.00	3.20	2.50	3.00
5	1.30	2.00	.90	3.60	2.00	1.70	1.60	1.20	3.90	3.20	2.50	2.25
6	1.10	1.70	.80	3.15	2.20	1.60	2.00	5.50	3.70	3.00	2.40	2.20
7	1.20	1.50	.80	2.70	2.20	1.60	1.80	10.50	3.60	3.50	2.40	2.10
8	1.20	1.50	.80	2.70	2.10	1.60	2.10	3.85	3.50	3.20	2.40	1.90
9	1.20	1.40	.80	2.55	2.10	1.50	2.00	3.50	3.70	3.20	2.40	2.20
10	1.20	1.20	.60	2.40	2.10	1.50	1.90	3.00	3.70	3.20	2.20	2.20
11	1.90	1.40	3.75	2.20	2.60	1.50	1.80	3.00	3.60	3.20	2.30	2.20
12	7.00	1.40	2.60	2.10	2.60	1.50	1.70	2.70	3.80	3.20	2.30	2.20
13	3.20	1.50	1.80	2.30	2.20	1.60	1.70	3.00	3.80	4.00	2.30	2.20
14	3.20	1.30	1.40	4.75	2.10	3.15	1.50	14.00	4.10	4.00	2.50	2.80
15	2.65	1.30	1.20	3.25	2.10	6.50	1.60	7.50	3.50	3.10	2.30	8.50
16	2.10	1.50	1.20	2.70	2.00	5.75	1.60	4.50	3.90	3.00	2.20	4.20
17	1.80	1.10	1.00	2.45	2.00	4.50	1.60	4.00	7.50	3.00	2.00	3.25
18	1.60	1.50	1.20	2.35	2.00	3.80	1.60	4.25	5.70	2.90	2.20	2.80
19	1.60	1.30	1.20	4.90	2.30	3.75	2.10	4.00	4.50	2.90	2.20	2.70
20	1.40	1.20	1.20	12.40	2.85	3.50	1.80	3.75	4.20	2.70	2.10	2.65
21	1.60	1.20	1.20	7.00	5.00	4.05	1.50	4.00	4.00	2.90	2.10	2.90
22	1.50	1.10	1.20	4.00	21.00	2.75	1.70	5.25	3.50	2.90	2.10	2.60
23	1.50	1.10	1.20	3.60	8.50	3.00	1.60	4.25	3.80	2.90	2.10	2.85
24	1.50	.80	1.00	3.50	4.90	5.50	1.60	5.00	3.50	2.90	2.90	2.85
25	1.40	1.00	1.40	3.15	4.30	4.00	1.50	4.25	3.20	2.90	3.00	2.70
26	1.40	.95	5.50	2.85	4.00	2.50	1.65	4.25	3.20	2.90	2.10	2.85
27	1.30	.90	10.00	2.65	3.80	2.50	1.60	4.00	3.20	2.70	2.00	2.95
28	1.30	.90	4.00	2.65	3.50	2.50	1.30	5.75	3.40	2.80	2.00	3.25
29	1.20	.....	3.00	2.55	3.00	3.50	1.50	5.00	4.00	2.80	2.00	15.40
30	1.20	.....	2.60	2.50	2.80	2.90	1.50	5.00	3.80	2.80	2.00	13.50
31	1.20	.....	2.45		2.50	.....	1.85	4.50		2.70		5.15

BROAD RIVER (OF THE CAROLINAS) NEAR ALSTON, S. C.

This station is described in Water-Supply Paper No. 48, page 146. Results of measurements for 1900 are given in the Twenty-second Annual Report, Part IV, page 158. During 1901 the following discharge measurements were made by E. W. Myers and others:

April 5: Gage height, 14.20 feet; discharge, 35,387 second-feet.
April 22: Gage height, 10.10 feet; discharge, 22,663 second-feet.
May 24: Gage height, 19.47 feet; discharge, 82,750 second-feet.
July 30: Gage height, 3.93 feet; discharge, 4,547 second-feet.
November 18: Gage height, 3.80 feet; discharge, 4,267 second-feet.

Daily gage height, in feet, of Broad River near Alston, S. C., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	5.90	4.20	3.40	5.40	4.60	6.85	5.78	4.25	13.00	6.20	4.10	3.90
2	5.49	3.95	3.45	12.25	4.47	5.50	4.30	3.75	12.23	5.20	4.05	3.85
3	6.05	5.60	3.35	20.80	4.37	4.90	4.40	4.20	9.70	6.25	4.15	3.95
4	4.90	12.25	3.20	21.60	4.20	4.80	4.05	3.60	7.90	5.75	4.05	4.50
5	4.40	10.10	3.30	13.30	4.05	4.50	4.10	3.45	6.30	5.15	4.10	5.10
6	4.05	7.60	3.35	8.80	3.95	4.35	3.95	9.32	5.95	4.75	4.25	4.40
7	3.90	5.40	3.30	6.15	4.10	4.95	3.95	13.38	5.60	4.70	4.15	4.15
8	3.85	4.75	3.20	5.40	4.15	4.90	4.00	13.45	5.45	4.75	4.05	4.15
9	3.80	6.75	3.20	5.20	3.90	4.35	4.70	7.05	5.15	4.60	4.05	3.90
10	3.65	6.83	3.45	4.90	4.25	4.10	5.30	9.33	5.20	4.60	4.00	4.20
11	4.00	5.35	3.95	4.55	3.80	3.90	4.65	6.70	5.10	4.58	3.90	4.45
12	5.85	4.14	8.40	4.35	3.95	4.05	4.35	7.55	5.10	4.48	4.00	4.60
13	10.30	4.90	6.15	4.15	3.95	4.00	4.10	5.95	5.05	6.85	3.90	4.25
14	8.05	4.50	4.65	8.50	3.75	8.20	3.90	6.10	5.85	7.45	4.15	4.10
15	6.40	4.30	4.05	9.20	3.60	12.15	4.25	14.52	5.05	5.55	4.05	9.00
16	5.30	4.15	3.85	6.60	3.45	14.65	4.35	19.30	4.85	4.85	3.95	14.40
17	5.58	4.00	3.70	5.55	3.50	16.25	4.80	21.72	12.10	4.70	4.00	8.95
18	5.40	3.90	3.60	5.00	3.55	12.25	5.05	19.41	17.73	4.55	3.80	6.50
19	4.40	3.80	3.45	7.75	3.55	8.52	5.95	13.97	18.77	4.38	3.95	5.25
20	4.25	3.70	3.40	16.95	5.60	7.40	6.95	9.60	15.90	4.45	3.95	4.95
21	4.10	3.58	3.60	19.22	9.47	7.25	6.25	8.70	9.55	4.35	3.95	4.70
22	3.90	3.50	3.65	11.13	17.38	7.45	4.50	7.90	6.60	4.45	3.95	4.45
23	3.95	3.50	3.55	7.65	23.56	6.10	4.00	8.00	5.95	4.35	3.85	4.30
24	3.98	3.55	3.55	6.90	17.73	5.55	3.95	12.55	5.60	4.25	4.25	5.05
25	4.50	3.50	3.60	6.25	10.50	5.55	3.85	11.25	5.30	4.25	4.82	5.15
26	4.05	3.50	11.78	5.70	6.80	5.15	4.18	7.95	5.15	4.15	4.40	4.80
27	3.95	3.55	21.02	5.30	7.80	7.40	4.20	14.75	4.90	4.25	4.15	4.90
28	3.85	3.48	17.55	5.05	7.85	5.25	5.35	15.53	4.75	4.25	3.95	7.60
29	3.78	.....	11.40	4.80	6.60	5.35	4.20	15.25	5.95	4.25	3.90	14.70
30	3.90	.....	6.45	4.75	5.75	5.45	4.03	16.50	6.90	4.20	3.90	20.92
31	4.90	.....	5.85	.....	5.90	.....	3.95	12.95	.....	4.15	.....	23.55

SALUDA RIVER AT WATERLOO, S. C.

This station is described in Water-Supply Paper No. 48, page 147. Records of flow during 1900 will be found in the Twenty-second Annual Report, Part IV, page 159. During 1901 the following measurements were made by E. W. Myers and others.

April 5: Gage height, 10.37 feet; discharge, 4,903 second-feet.
May 1: Gage height, 5.20 feet; discharge, 1,446 second-feet.
July 30: Gage height, 4.40 feet; discharge, 942 second-feet.
November 19: Gage height, 4.70 feet; discharge, 871 second-feet.

Daily gage height, in feet, of Saluda River at Waterloo, S. C., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	5.50	4.95	4.50	5.15	5.25	7.50	5.90	4.35	15.20	6.45	5.15	5.30
2	5.50	5.55	5.00	13.45	5.80	6.40	5.90	4.35	13.30	7.30	5.50	3.75
3	5.95	8.25	4.50	19.65	5.10	6.00	5.20	5.05	8.70	8.65	6.04	5.20
4	5.00	13.70	4.70	17.80	5.60	5.60	6.15	4.20	7.90	7.45	4.85	5.30
5	5.50	9.95	4.60	10.85	5.20	4.90	4.85	3.50	7.65	6.25	5.10	5.15
6	5.00	7.10	4.40	8.10	5.80	7.85	5.45	8.15	7.55	6.45	5.05	4.75
7	4.30	5.60	4.40	7.20	5.45	7.45	5.70	9.95	6.90	5.65	5.05	4.60
8	5.45	5.40	4.50	7.00	5.65	6.15	6.05	11.40	7.30	5.95	4.95	6.10
9	4.65	8.05	5.20	6.45	4.85	6.20	6.20	6.80	6.95	5.90	5.40	4.45
10	4.55	7.60	5.35	6.30	5.30	4.80	6.80	5.60	6.50	5.55	5.95	4.70
11	5.15	5.65	10.00	6.00	4.90	5.10	5.00	7.85	6.40	5.50	4.00	4.40
12	9.20	5.75	8.45	5.65	5.85	5.00	5.00	5.55	6.75	5.80	4.85	4.50
13	11.50	5.90	5.65	6.45	4.05	5.45	5.10	6.65	6.45	8.10	4.40	5.30
14	10.80	5.20	5.25	10,30	4,50	11.00	4.95	7.00	6.60	6.80	4.80	4.65
15	6.65	5.20	4.95	8.35	4.95	20.00	4.85	14.85	6.95	5.90	4.75	12.35
16	6.15	5.80	5.20	7.05	4.70	17.50	5.45	20.85	5.45	5.70	4.90	10.20
17	6.05	6.10	5.05	6.45	4.55	12.30	5.00	19.05	14.20	5.60	5.45	7.05
18	5.75	5.90	5.00	6.15	5.20	8.70	6.10	14.80	22.10	5.40	3.75	6.00
19	5.60	5.65	4.65	8.00	5.05	7.60	4.80	11.95	18.80	5.80	4.70	5.40
20	6.15	4.85	4.50	9.65	8.55	7.40	6.60	10.70	11.00	5.35	4.65	5.20
21	4.50	4.80	4.55	10.10	13.55	7.35	6.05	11.00	8.15	4.90	4.95	5.00
22	4.80	5.40	4.60	8.05	19.20	6.90	5.10	10.85	7.60	5.80	4.40	6.50
23	5.50	4.95	5.50	7.20	17.50	8.35	4.25	12.55	7.25	5.20	4.90	5.30
24	5.40	6.30	5.25	7.10	11.25	6.85	4.40	8.00	7.05	5.00	5.55	4.20
25	5.75	4.10	4.40	6.85	7.60	6.20	4.30	8.95	6.90	5.05	5.10	5.75
26	5.60	5.45	12.30	6.25	7.70	6.95	4.50	8.70	6.65	5.40	5.30	5.15
27	5.25	5.50	18.85	5.80	6.00	6.95	6.55	13.00	6.40	5.45	5.45	6.45
28	4.90	4.90	15.30	6.40	6.55	6.65	6.15	17.15	5.95	5.50	5.00	11.60
29	5.20	.....	7.75	4.70	6.50	7.00	4.60	18.75	6.55	5.25	5.25	16.50
30	5.30	.....	6.90	5.60	5.30	7.10	4.35	17.15	7.15	4.95	5.00	21.35
31	5.00	.....	7.20	.....	6.25	.....	4.67	14.60	.....	4.85	.....	19.15

TALLULAH RIVER AT TALLULAH FALLS, GA.

This station was established August 29, 1900, and records of gage heights were obtained until October 19, 1900, when the observer left Tallulah Falls, and no readings were taken until January 18, 1901, when the record was resumed. The observer is P. T. Shore. This station was discontinued December 31, 1901. It is described in Water-Supply Paper No. 48, page 148. During 1901 the following measurements were made by F. A. Murray and others.

List of discharge measurements of Tallulah River at Tallulah Falls, Ga.

Date.	Hydrographer.	Gage height.	Discharge
1901.		*Feet.*	*Sec. feet.*
January 18	F. A. Murray	1.95	681
February 15	do	1.85	617
April 4	do	2.80	1,227
May 22	do	3.94	2,161
May 23	do	3.24	1,566
Do	do	3.15	1,479
July 15	do	1.58	488
August 27	K. T. Thomas	3.45	1,601
September 18	do	2.80	1,309
October 19	do	1.55	506

Daily gage height, in feet, of Tallulah River at Tallulah Falls, Ga., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	1.90	1.80	2.70	2.40	2.50	3.25	1.40	3.20	1.85	1.40	1.25
2	.....	1.90	1.80	4.95	2.35	2.30	2.20	1.35	3.15	1.85	1.40	1.30
3	.....	2.95	1.75	4.90	2.30	2.20	2.20	1.30	3.10	1.80	1.40	1.30
4	.....	2.40	1.70	2.90	2.25	2.10	2.15	1.30	3.00	1.80	1.40	1.35
5	.....	2.00	1.65	2.85	2.25	2.05	2.10	1.25	3.90	1.80	1.40	1.35
6	.....	2.00	1.60	2.80	2.25	1.95	2.05	6.35	3.85	1.75	1.40	1.30
7	.....	1.95	1.60	2.75	2.20	1.90	2.00	4.25	3.85	1.75	1.40	1.30
8	.....	2.20	1.60	2.70	2.15	1.80	2.00	3.15	3.75	1.70	1.35	1.30
9	.....	2.20	1.60	2.60	2.10	1.80	1.95	2.75	3.70	1.70	1.35	1.30
10	.....	2.10	1.95	2.55	2.05	1.75	1.90	2.05	3.70	1.70	1.35	1.30
11	.....	2.00	2.10	2.45	2.00	1.75	1.90	1.90	3.60	1.65	1.35	1.40
12	.....	1.95	1.95	2.40	2.00	1.70	1.85	1.80	3.60	1.65	1.35	1.40
13	.....	1.95	1.70	2.60	1.85	1.80	1.80	1.90	3.50	1.65	1.35	1.35
14	.....	1.95	1.65	2.50	1.85	2.10	1.70	6.85	3.50	1.65	1.35	2.80
15	.....	1.90	1.65	2.40	1.80	2.00	1.60	3.90	3.40	1.65	1.30	2.80
16	.....	1.85	1.60	2.30	1.75	2.10	1.60	4.30	3.35	1.60	1.30	2.75
17	.....	1.85	1.55	2.20	1.75	2.20	1.55	5.40	3.25	1.60	1.30	2.75
18	1.95	1.85	1.55	2.10	1.70	2.40	1.55	3.40	3.10	1.60	1.30	2.70
19	1.90	1.85	1.50	5.50	1.90	2.50	2.00	3.15	2.90	1.60	1.35	2.70
20	1.90	1.80	1.50	5.50	2.50	2.50	2.15	2.75	2.60	1.55	1.35	2.70
21	1.90	1.80	2.00	3.80	8.50	2.40	2.05	2.40	2.30	1.55	1.30	2.65
22	1.90	1.80	1.95	3.60	4.90	2.30	1.95	4.55	2.20	1.55	1.30	2.40
23	1.95	1.80	1.85	3.30	3.30	2.30	1.85	4.25	2.10	1.50	1.30	2.15
24	1.95	1.80	1.85	2.90	2.80	2.25	1.75	3.80	2.00	1.50	1.30	1.80
25	1.90	1.80	7.50	2.80	2.60	2.25	1.70	3.50	1.95	1.50	1.30	1.60
26	1.90	1.80	6.50	2.75	2.50	2.35	1.65	3.20	1.95	1.50	1.30	1.50
27	1.90	1.80	4.50	2.70	2.45	2.40	1.55	3.30	1.90	1.50	1.30	1.45
28	1.90	1.80	3.90	2.60	2.40	2.40	1.55	5.80	1.90	1.45	1.30	1.40
29	1.90	.....	2.95	2.50	2.40	2.35	1.50	4.10	1.90	1.45	1.25	10.50
30	1.90	.....	2.90	2.45	2.35	2.30	1.50	3.15	1.95	1.45	1.25	5.80
31	1.95	.....	2.75	.....	2.30	.....	1.40	2.30	.....	1.40	.....	4.10

TUGALOO RIVER NEAR MADISON, S. C.

This station was established July 19, 1898, at Cook's ferry, about a half mile from Madison, S. C.

During 1901 the ferry at which the station was located was changed to a different point on the river, and the station was discontinued at the end of the year.

The station is described in Water-Supply Paper No. 48, page 149. Results of measurements are given in the Twentieth Annual Report, Part IV, page 162; the Twenty-first Annual Report, Part IV, page 131, and the Twenty-second Annual Report, Part IV, page 160.

During 1901, the following measurements were made by F. A. Murray and others:

February 14: Gage height, 3.40 feet; discharge, 1,669 second-feet.
May 24: Gage height, 5.65 feet; discharge, 3,120 second-feet.

Daily gage height, in feet, of Tugaloo River near Madison, S. C., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.30	2.90	2.40	4.40	4.70	4.60	4.10	2.40	7.30	3.70	2.50	1.90
2	3.10	2.80	2.60	6.60	4.60	4.10	3.80	2.40	6.70	3.90	2.50	1.90
3	2.80	3.00	2.50	10.30	4.50	3.00	3.40	2.30	6.10	4.00	2.50	3.10
4	2.70	6.90	2.50	6.70	4.40	3.90	3.30	2.30	5.60	3.60	2.40	2.70
5	2.60	4.30	2.50	5.80	4.30	3.80	3.20	2.10	5.40	3.50	2.50	2.60
6	2.50	3.90	2.40	5.50	4.40	3.70	3.40	4.10	5.20	3.40	2.40	2.40
7	2.50	3.50	2.30	4.00	4.30	4.10	4.20	9.80	5.10	3.30	2.30	2.20
8	2.40	3.40	2.30	4.70	4.00	5.80	3.40	4.50	4.90	3.20	2.30	2.00
9	2.40	4.80	2.30	4.40	4.00	3.50	3.20	3.60	4.80	3.20	2.30	4.10
10	2.40	4.40	3.30	4.40	4.90	3.40	3.00	3.20	4.70	3.20	2.30	3.10
11	10.35	3.90	4.00	4.30	4.90	3.40	2.90	3.60	5.40	3.20	2.20	3.00
12	12.40	3.80	3.30	4.20	3.80	3.10	2.80	3.90	4.50	3.10	2.20	2.90
13	6.70	3.60	3.00	4.10	3.70	3.40	2.70	4.00	4.90	3.60	2.40	2.60
14	5.50	3.50	2.90	6.70	3.60	5.50	2.80	12.10	3.90	3.20	2.30	3.20
15	4.60	3.30	2.60	5.60	3.60	9.10	2.70	10.50	4.10	3.10	2.10	9.90
16	4.20	3.10	2.60	4.70	3.50	8.00	4.10	11.30	9.70	3.10	2.10	6.90
17	4.20	3.10	2.50	4.30	3.00	5.60	3.30	12.30	8.60	3.00	2.00	5.10
18	3.90	3.00	2.50	4.20	3.00	6.60	2.70	11.50	7.90	3.00	2.00	4.30
19	3.50	3.00	2.50	7.30	3.80	4.20	4.30	8.30	6.50	3.90	2.10	4.10
20	3.30	2.90	2.40	22.00	5.20	4.40	4.10	7.50	4.90	2.90	2.10	3.90
21	3.30	2.80	6.10	9.60	9.90	4.30	3.10	7.30	4.60	2.80	2.00	3.70
22	3.20	2.70	3.70	7.40	17.10	4.10	3.40	10.95	4.30	2.80	2.00	3.20
23	3.10	2.60	3.20	6.70	8.60	3.90	2.80	18.50	4.20	2.80	2.00	3.10
24	3.20	2.70	3.60	6.10	5.90	4.00	2.60	10.10	4.10	2.70	2.50	3.40
25	3.30	2.60	7.90	5.70	5.70	3.90	2.50	7.60	4.00	2.70	2.20	3.60
26	3.30	2.50	19.60	5.60	5.20	5.20	2.50	7.80	3.90	2.70	2.10	3.70
27	3.00	2.40	10.10	5.20	4.80	4.90	3.10	6.90	3.70	2.60	2.00	4.00
28	3.10	2.40	6.70	5.20	4.60	4.90	2.50	9.70	3.80	2.60	1.90	4.00
29	3.90	.....	5.70	4.90	4.40	4.60	2.40	11.90	4.20	2.60	1.90	20.00
30	3.80	.....	4.50	4.80	4.20	4.20	2.50	9.00	3.90	2.50	1.90	10.00
31	2.80	.....	4.40	.....	4.30	.....	2.50	8.60	.....	2.50	.....	7.10

SAVANNAH RIVER NEAR CALHOUN FALLS, S. C.

This station was established August 4, 1896, on the Seaboard Air Line bridge across the Savannah River, and is described in Water-Supply Paper No. 48, page 149. Results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 161. The following measurements of discharge were made at this point during 1901 by K. T. Thomas:

January 21: Gage height, 3.15 feet; discharge, 5,331 second-feet.
April 25: Gage height, 4.60 feet; discharge, 10,430 second-feet.
August 13: Gage height, 4.55 feet; discharge, 10,843 second-feet.

Daily gage height, in feet, of Savannah River near Calhoun Falls, S. C., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.40	3.30	2.80	4.00	3.80	4.90	4.00	2.90	4.80	3.40	2.40	2.10
2	3.60	3.20	2.70	4.20	3.70	4.20	3.90	2.90	4.70	3.30	2.30	2.10
3	3.60	3.30	2.70	11.50	3.70	4.00	3.80	2.80	4.50	3.30	2.30	2.20
4	3.50	6.60	2.70	10.00	3.60	3.90	3.80	2.80	4.30	3.20	2.20	2.20
5	3.50	6.00	2.70	7.30	3.60	3.80	3.70	2.70	4.00	3.20	2.20	2.30
6	3.40	4.40	2.70	5.00	3.60	3.80	3.60	3.00	3.90	3.20	2.20	2.30
7	3.40	3.90	2.60	4.40	3.50	3.70	3.40	8.50	3.70	3.10	2.10	2.30
8	3.40	3.60	2.60	4.20	3.50	3.70	3.40	4.50	3.60	3.10	2.10	2.20
9	3.30	3.70	2.60	4.00	3.50	3.60	3.30	3.90	3.40	3.00	2.00	2.20
10	3.40	3.60	2.70	3.90	3.40	3.50	3.30	3.30	3.20	3.00	2.00	2.50
11	3.60	3.50	3.20	3.80	3.40	3.50	3.20	3.20	3.10	2.90	2.00	2.50
12	5.90	3.50	4.00	3.80	3.30	3.40	3.10	4.00	3.00	2.90	2.00	2.40
13	6.00	3.40	3.60	3.80	3.30	3.50	3.20	4.90	3.00	3.20	1.90	2.40
14	4.80	3.20	3.30	4.20	3.30	6.00	3.20	5.20	2.90	3.00	1.90	2.60
15	4.40	3.10	3.20	4.60	3.20	11.80	3.10	7.50	2.90	3.00	1.90	5.00
16	4.00	3.10	3.00	4.20	3.10	13.00	3.10	11.00	2.90	2.90	1.90	5.30
17	4.00	3.00	3.00	4.00	3.10	7.50	3.00	8.00	4.00	2.90	1.90	5.00
18	3.90	3.00	3.00	3.90	3.00	5.00	3.00	5.90	17.20	2.80	2.00	4.50
19	3.80	2.90	3.00	4.90	3.10	4.10	3.20	5.00	11.50	2.80	2.00	4.20
20	3.80	2.90	2.90	8.50	4.30	4.00	3.00	4.50	6.00	2.70	2.30	4.00
21	3.70	2.90	3.10	10.20	6.00	3.90	2.90	4.00	4.00	2.70	2.40	3.90
22	3.60	2.80	3.00	6.00	10.20	3.80	2.90	4.80	3.80	2.70	2.40	3.80
23	3.60	2.80	3.00	4.90	8.20	4.20	2.80	9.90	3.70	2.60	2.30	3.80
24	3.70	2.90	3.20	4.20	5.00	4.00	2.70	8.20	3.70	2.60	2.20	4.20
25	3.40	3.00	3.10	4.00	4.80	4.00	2.70	5.40	3.60	2.60	2.20	4.00
26	3.30	2.90	11.00	3.90	4.50	3.90	2.90	4.00	3.60	2.50	2.20	4.50
27	3.20	2.90	16.50	3.80	4.50	3.90	3.00	5.50	3.50	2.50	2.10	4.70
28	3.10	2.80	10.00	3.90	4.30	3.80	2.90	13.30	3.50	2.50	2.10	6.20
29	3.10	.....	7.50	3.90	4.10	3.90	2.90	10.00	3.40	2.50	2.10	12.00
30	3.10	.....	5.00	3.80	4.00	4.00	3.20	7.70	3.40	2.40	2.10	17.90
31	3.40	.....	4.40	.....	4.00	.....	3.00	5.00	.....	2.40	.....	10.00

SAVANNAH RIVER AT AUGUSTA, GA.

Observations of river heights have been maintained at the highway bridge in the city of Augusta since 1875. The station is described in Water-Supply Paper No. 48, page 150. The gage heights as published are the average of four daily readings reduced to feet and hundredths. Discharge measurements are made at the North Augusta highway bridge. Records of flow during 1900 will be found in the Twenty-second Annual Report, Part IV, page 162.

The following measurements were made by Max Hall and F. A. Murray during 1901:

January 19: Gage height, 11.65 feet; discharge, 13,041 second-feet.
February 21: Gage height, 8.55 feet; discharge, 7,664 second-feet.
April 4: Gage height, 32.10 feet; discharge, 127,106 second-feet.
August 10: Gage height, 10.00 feet; discharge, 9,720 second-feet.

Daily gage height, in feet, of Savannah River at Augusta, Ga., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	15.20	10.40	8.30	14.00	10.10	14.10	12.20	8.30	18.40	10.80	8.40	8.20
2	15.28	9.50	8.20	14.70	10.00	13.30	11.60	7.80	18.20	11.90	8.40	8.40
3	17.30	10.00	8.00	30.30	9.80	11.40	9.90	7.40	15.00	12.20	8.30	8.20
4	15.12	25.60	8.20	30.90	9.50	10.10	8.90	7.20	12.80	12.10	8.50	8.90
5	12.40	26.70	8.10	23.80	9.40	9.80	8.80	7.30	11.40	10.10	8.40	9.90
6	10.28	20.40	8.00	18.50	9.30	9.80	8.50	7.70	10.80	9.40	8.70	9.10
7	9.37	16.10	8.00	14.30	9.30	15.00	8.30	12.90	10.40	9.30	8.50	8.60
8	8.95	12.70	7.80	12.70	9.30	15.70	8.60	18.90	10.00	9.10	8.40	8.60
9	8.62	14.00	7.80	11.60	9.20	12.10	9.00	13.20	9.90	9.20	8.50	8.60
10	8.55	17.30	8.10	11.00	9.00	9.60	8.90	10.00	9.80	8.90	8.30	8.40
11	8.55	15.30	10.10	10.60	8.80	9.00	8.70	9.20	9.70	8.70	8.40	8.50
12	17.12	12.70	14.90	10.30	8.50	9.10	8.20	12.00	10.00	8.80	8.50	9.10
13	23.45	11.60	11.80	10.50	8.60	10.40	7.70	10.60	9.80	11.20	8.70	8.90
14	19.18	10.70	9.80	17.60	8.70	21.70	8.10	11.30	9.60	12.00	8.40	8.90
15	14.65	10.20	8.90	18.60	8.60	26.90	8.40	18.10	9.30	10.80	8.50	14.80
16	11.80	9.80	8.60	14.90	8.50	26.20	9.20	19.80	9.20	9.10	8.50	23.10
17	11.90	9.30	8.20	12.40	8.50	23.00	8.70	22.40	10.70	9.00	8.20	17.20
18	13.30	8.20	8.20	11.30	8.30	17.80	9.30	21.80	28.50	8.90	8.50	12.40
19	11.55	9.10	8.00	11.70	8.90	14.80	9.70	19.70	30.90	8.60	8.40	10.70
20	9.87	8.90	8.00	19.60	15.10	12.10	13.30	17.90	25.50	8.40	8.40	9.90
21	9.48	8.60	8.00	23.60	20.80	11.00	12.40	15.80	17.10	8.20	8.50	9.30
22	9.05	8.60	8.70	18.20	25.60	11.20	9.80	17.00	13.10	8.40	8.60	9.20
23	9.00	8.60	9.40	14.80	27.00	11.70	9.00	20.20	11.50	8.40	8.60	9.10
24	9.07	8.70	8.60	13.30	10.60	12.20	8.20	24.00	10.70	8.60	8.40	9.60
25	10.28	8.70	8.90	12.40	15.00	11.70	8.00	21.60	10.20	8.70	8.80	10.20
26	10.32	8.70	15.10	11.70	13.50	11.80	8.00	16.80	10.00	8.50	8.60	9.90
27	9.47	8.70	27.70	11.20	14.00	11.00	10.00	13.90	9.70	8.50	8.50	9.70
28	9.12	8.40	28.00	10.80	11.90	10.20	9.80	22.00	9.30	8.60	8.40	13.30
29	9.05	.....	20.30	10.50	11.10	10.80	9.30	28.70	9.80	8.30	8.40	23.10
30	8.95	.....	14.80	10.20	10.40	10.90	9.10	26.10	10.70	8.40	8.30	29.60
31	9.85	.....	14.40	.....	10.80	.....	8.40	21.40	.....	8.60	.....	30.40

BROAD RIVER (OF GEORGIA) NEAR CARLTON, GA.

This station, established May 27, 1897, is located on the bridge of the Seaboard Air Line 3 miles east of Carlton, Ga., and 3 miles above the mouth of the South Fork. A description of the station is given in Water-Supply Paper No. 48, page 151. Records of flow for 1900 will be found in the Twenty-second Annual Report, Part IV, page 163. During 1901 the following measurements were made by K. T. Thomas:

January 1: Gage height, 3.55 feet; discharge, 1,497 second-feet.
January 22: Gage height, 2.85 feet; discharge, 991 second-feet.
April 23: Gage height, 3.50 feet; discharge, 1,807 second-feet.
August 4: Gage height, 5.25 feet; discharge, 3,173 second-feet.

Daily gage height, in feet, of Broad River, of Georgia, near Carlton, Ga., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.60	3.20	2.60	3.60	2.70	4.30	3.90	2.40	5.00	2.90	2.56	2.50
2	3.20	2.90	2.60	6.90	2.60	3.90	3.10	2.30	3.90	2.90	2.50	2.50
3	3.60	3.80	2.60	11.95	2.60	3.30	3.00	2.30	3.50	4.80	2.50	3.00
4	3.50	7.90	2.60	9.30	2.60	3.00	2.90	2.30	3.10	2.90	2.50	3.40
5	3.30	6.80	2.60	4.50	2.50	2.90	2.80	2.30	3.00	2.80	2.60	3.40
6	2.80	4.10	2.60	3.90	2.90	2.80	2.70	2.50	2.90	2.70	2.50	2.70
7	2.70	3.50	2.60	3.60	2.90	3.70	2.70	4.40	2.90	2.70	2.50	2.70
8	2.70	3.30	2.50	3.40	2.80	3.00	2.70	4.00	2.80	2.60	2.50	2.60
9	2.60	4.20	2.50	3.30	2.80	2.80	2.60	3.00	2.80	2.60	2.50	2.60
10	2.60	4.80	2.50	3.20	2.70	2.70	2.60	2.60	2.70	2.60	2.50	2.90
11	5.90	3.80	4.40	3.10	2.70	2.70	2.50	4.30	2.70	2.50	2.50	2.80
12	11.40	3.50	4.10	3.10	2.70	3.10	2.50	3.20	3.00	2.50	2.50	2.70
13	11.50	3.20	3.20	3.10	2.70	2.90	2.40	2.80	2.80	3.00	2.60	2.60
14	5.00	3.10	3.00	5.50	2.60	4.30	2.40	5.50	2.70	3.00	2.60	2.70
15	4.10	3.00	2.90	4.90	2.60	11.10	2.60	6.00	2.70	2.80	2.50	5.30
16	3.40	2.90	2.80	3.90	2.60	11.20	2.60	10.00	2.75	2.70	2.50	4.20
17	3.40	2.90	2.70	3.50	2.60	5.00	4.60	8.40	6.60	2.70	2.50	3.10
18	3.00	2.90	2.70	3.40	3.00	3.90	3.20	5.40	14.80	2.60	2.50	2.90
19	3.00	2.80	2.60	3.60	3.50	3.60	4.60	3.90	8.60	2.60	2.60	2.80
20	2.90	2.80	2.60	4.40	5.70	3.30	6.30	4.30	4.60	2.60	2.60	2.70
21	2.80	2.70	3.00	4.30	5.70	3.20	3.50	6.70	3.60	2.60	2.70	2.70
22	2.80	2.70	2.90	4.00	7.90	3.20	2.80	5.40	3.30	2.60	2.60	2.60
23	2.80	2.70	2.80	3.50	7.70	3.80	2.70	7.30	3.10	2.50	2.60	2.60
24	2.90	2.80	2.80	3.30	4.00	3.60	2.60	9.00	3.00	2.50	2.60	3.10
25	3.60	2.80	2.80	3.20	3.40	4.80	2.50	5.10	2.90	2.50	2.60	3.00
26	3.10	2.70	14.25	3.20	3.50	4.00	2.50	4.30	2.90	2.50	2.60	3.00
27	2.90	2.70	13.35	3.20	3.30	3.80	3.20	5.50	2.80	2.50	2.50	3.00
28	2.90	2.70	8.40	3.20	3.10	3.70	2.80	8.40	2.90	2.50	2.50	4.00
29	2.80	.....	4.20	3.00	3.00	3.60	2.60	6.30	3.00	2.50	2.50	14.20
30	2.80	.....	3.60	2.80	2.90	5.90	2.60	6.50	2.90	2.50	2.50	19.90
31	3.50	.....	3.60	.....	2.90	.....	2.50	4.90	.....	2.50	.....	12.40

MIDDLE OCONEE RIVER NEAR ATHENS, GA.

Middle Oconee River rises in Hall County and flows southeastward through Jackson and Clarke counties to its junction with the east fork 6 miles below Athens. It drains a rolling watershed of 300 square miles.

Measurements were begun at Athens on October 11, 1901; the station having been established by Prof. C. M. Strahan of the University of Georgia. It is located on a wagon bridge known as Mitchell's bridge, on the Athens and Lawrenceville road, 3½ miles from Athens and about 7½ miles above the junction of Middle Oconee with its eastern fork. It is 4 miles above the dam of the Princeton factory, an 8-foot shoal intervening, and one-third of a mile below the dam of the Athens Electric Railway Company. The gage is of wire, mounted on the north truss near the east end of the bridge; it is protected by a plank cover and locked. The bridge is of the covered, wooden lattice type. The bench mark is the top of the lower chord at the gage pulley, 26.85 feet above the river bottom, which is the zero point of the gage, the latter being set to read zero when the weight touches the bottom. The gradations are laid off on the lower chord to 20 feet and can be extended to 26 feet. Secondary gages of plank, 12 feet long each, are in place at the power house and at the head-gate of the race of the Athens Electric Railway Company plant, for use in time of extreme low flow. The initial point for soundings is a spike at the west end of the north bridge truss. The channel is straight and unobstructed, except by remains of old piers just inside the present piers, the former being covered at a gage height of 3 feet. The banks are high and the approaches short. The water rises rapidly in

time of flood, maximum gage height being 22.9 feet, and average gage height, 2.5 to 3 feet. In the year 1901 the following measurements were made by C. M. Strahan:

October 11: Gage height, 2.80 feet; discharge, 498 second-feet.
October 26: Gage height, 2.80 feet, discharge, 491 second-feet.
December 31: Gage height, 11.18 feet, discharge, 6,779 second-feet.

Daily gage height, in feet, of Middle Oconee River, near Athens Ga., for 1901.

Day.	Oct.	Nov.	Dec.	Day.	Oct.	Nov.	Dec.
1		2.80	2.70	17	2.80	2.70	3.20
2		2.70	2.70	18	2.80	2.70	3.00
3		2.70	3.10	19	2.80	2.80	2.90
4		2.80	3.10	20	2.80	3.00	2.80
5		2.90	2.90	21	2.80	2.90	2.80
6		2.80	2.90	22	2.80	2.80	2.80
7		2.80	2.80	23	2.80	2.80	3.10
8		2.80	2.80	24	2.80	2.80	3.40
9		2.70	2.80	25	2.80	2.70	3.30
10		2.70	3.00	26	2.80	2.70	3.20
11	2.80	2.70	3.00	27	2.70	2.70	3.20
12	2.90	2.80	2.80	28	2.80	2.60	4.20
13	2.90	2.80	2.80	29	2.80	2.70	11.20
14	3.00	2.80	2.90	30	2.80	2.70	18.00
15	2.90	2.80	4.30	31	2.80		10.20
16	2.90	2.70	3.50				

OCONEE RIVER AT BARNETT SHOALS, GA.

This station was established by Prof. C. M. Strahan, of the University of Georgia, on August 6, 1901. It is located at Barnett's bridge, 1 mile above Barnett Shoals and 4 miles east of Watkinsville, Ga.

The gage is a 10-foot rod graduated to feet and tenths, nailed to a tree on the left bank just above the bridge. The gage is extended to a length of 16 feet by means of a plank marked in feet fastened above the rod. The bench mark is a large nail driven in the tree, and its elevation is 6 feet above the datum of the gage.

Discharge measurements are made from the downstream side of the bridge, which is a covered, lattice, single-span bridge, with a total length of 109 feet between abutments. The observer is R. L. McRee, a storekeeper at Barnett Shoals, who is instructed to read the gage once daily at ordinary stages and twice daily during low stages, when the regularity of the flow is affected by the small dam of the Georgia factory, 6½ miles upstream. The following measurements were made during 1901:

List of discharge measurements of Oconee River at Barnett Shoals, Ga.

Date.	Hydrographer.	Gage height.	Discharge.
1901.		*Feet.*	*Sec. feet.*
May 2	C. M. Strahan	1.40	1,025
August 6	B. M. Hall	2.70	1,461
August 13	C. M. Strahan	4.53	1,882
September 6	do	2.22	825
September 20	do	4.77	2,832
October 19	do	2.05	808
December 30	do	12.10	16,668

Daily gage height, in feet, of Oconee River at Barnett Shoals, Ga., for 1901.

Day.	Aug.	Sept.	Oct.	Nov.	Dec.	Day.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	3.30	2.30	2.00	2.10	17	6.00	6.40	2.10	2.00	3.00
2	.....	3.00	3.50	2.00	2.10	18	3.80	8.30	2.10	2.00	2.60
3	.....	2.70	3.90	2.00	2.00	19	4.80	8.60	2.05	2.10	2.30
4	.....	2.50	3.00	2.00	2.30	20	5.90	4.70	2.10	2.20	2.20
5	.....	2.40	2.50	2.00	2.20	21	4.80	3.20	2.10	2.20	2.10
6	.....	2.30	2.30	2.00	2.10	22	8.30	2.80	2.10	2.10	2.00
7	.....	2.30	2.20	2.00	2.00	23	9.70	2.60	2.05	2.10	2.30
8	.....	2.20	2.10	2.00	2.00	24	7.00	2.50	2.10	2.00	2.20
9	.....	2.20	2.10	2.00	2.00	25	4.00	2.40	2.00	2.00	2.10
10	.....	2.20	2.20	2.00	2.40	26	3.40	2.40	2.00	2.00	2.00
11	.....	2.50	2.20	2.00	2.30	27	6.50	2.30	2.00	2.00	3.00
12	.....	2.30	2.10	2.00	2.20	28	6.30	2.50	2.00	2.30	5.00
13	4.60	2.30	2.20	2.00	2.20	29	6.30	2.70	2.00	2.20	10.00
14	4.10	2.20	2.20	2.00	3.00	30	4.50	2.50	2.00	2.20	12.00
15	4.10	2.10	2.30	2.00	5.00	31	3.40	.....	2.00	.....	9.50
16	6.10	2.20	2.20	2.00	4.00						

APALACHEE RIVER NEAR BUCKHEAD, GA.

A gage was established at this station on February 13, 1901, and observations were commenced on March 1. It is located at the iron wagon bridge over the Apalachee River, 3½ miles north of the town of Buckhead, Ga The bridge is a single iron span 103 feet long, supported by four tubular iron piers. Its floor is about 25 feet above low water. The left bank is high and will overflow to a distance of about 75 feet only from edge of normal water. The right bank is liable to overflow to a distance of about 400 feet, commencing at a gage height of 6 feet. The overflow areas on both banks are crossed by wooden trestle approaches, the one on the right bank being subject to overflow at a gage height of 18 feet, thus rendering it impossible to make discharge measurements of high floods. The section is good, but the current irregular on account of the old bridge pier bases in the river about 50 feet above. The general course of the river both above and below the station is slightly curved.

The gage is graduated in feet and tenths, with brass figures and staples, and consists of two parts. The first section, extending from 0 to 10 feet, is fastened to a small ash tree on the left bank, about 100 feet below the bridge. The second section, extending from 6 to 20 feet, is nailed to the upstream post of the last wooden bent next to the iron bridge on the right bank.

Bench mark No. 1 is the top of the iron pier on right bank, downstream side. Its elevation is 25 feet above the datum of the gage.

Bench mark No. 2 is the top of the second iron crossbeam from the left bank on the downstream side. Its elevation is 25.72 feet above the datum of the gage.

The observer is A. S. Adams, a farmer living one-third mile from the bridge. The following measurements were made during 1901:

List of discharge measurements of Apalachee River near Buckhead, Ga.

Date.	Hydrographer.	Gage height.	Discharge.
1901.		*Feet.*	*Sec. feet.*
February 13	Max Hall	3.78	847
February 19	do	3.00	647
March 29	do	4.62	1,033
May 22	do	6.45	1,658
August 9	F. A. Murray	2.56	545
November 1	Max Hall	1.80	302

Daily gage height, in feet, of Apalachee River near Buckhead, Ga., for 1901.

Day.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1		2.60	4.90	2.70	6.10	3.50	2.00	3.50	2.20	1.70	1.90
2		2.60	5.30	2.60	3.60	3.00	1.90	3.00	2.20	1.70	2.00
3		2.60	14.00	2.60	3.10	2.70	1.80	2.80	2.40	1.70	2.00
4		2.60	13.80	2.50	3.00	2.60	1.90	2.60	3.50	1.75	2.50
5		2.50	7.50	2.50	2.90	2.50	1.80	2.40	2.60	1.90	2.40
6		2.50	5.30	2.60	2.80	2.40	1.80	2.20	2.40	1.90	2.20
7		2.40	4.50	2.50	8.50	2.10	2.00	2.10	2.20	1.80	2.10
8		2.40	4.00	2.40	8.50	2.00	6.50	2.10	2.20	1.80	2.00
9		2.40	3.60	2.40	3.40	2.90	2.70	2.00	2.10	1.80	2.20
10		2.50	3.40	2.30	3.10	2.50	2.50	2.00	2.10	1.80	3.00
11		4.50	3.20	9.30	2.90	2.40	4.00	1.90	2.00	1.80	2.80
12		5.70	3.10	2.20	2.80	2.30	6.00	1.90	1.90	1.80	2.20
13	3.78	3.50	3.10	2.60	2.70	2.10	3.50	1.80	1.90	1.80	2.20
14		3.00	7.00	2.40	4.00	2.60	3.10	1.80	1.85	1.85	2.10
15		2.70	6.70	2.50	4.50	1.90	3.00	1.80	1.85	1.85	8.00
16		2.60	5.50	2.20	4.50	3.00	5.00	1.90	1.80	1.80	7.00
17		2.50	4.10	2.20	6.00	2.70	10.50	4.00	1.80	1.80	6.60
18		2.50	3.70	2.10	4.50	2.50	5.70	10.50	1.80	1.80	4.50
19	3.00	2.40	3.90	2.40	4.00	4.00	4.50	12.50	1.80	1.90	4.10
20		2.40	5.00	2.80	3.80	6.00	4.00	7.00	1.80	2.10	4.00
21		2.70	4.30	4.40	3.50	6.00	4.00	5.00	1.80	2.10	3.80
22		2.60	3.50	6.80	3.20	3.00	4.50	3.20	1.80	2.20	3.60
23		2.50	3.30	3.50	3.50	2.50	4.00	3.00	1.80	2.20	3.60
24		2.90	2.20	3.00	2.80	2.20	3.50	2.80	1.75	2.00	4.20
25		3.00	3.10	2.60	2.50	2.10	4.00	2.70	1.75	1.90	3.90
26		7.50	3.00	2.40	5.00	2.60	3.80	2.60	1.75	1.90	3.60
27		11.50	2.90	2.30	4.00	2.90	3.60	2.40	1.75	1.90	3.60
28		8.00	2.80	2.30	3.90	3.00	4.50	2.20	1.75	1.90	4.50
29		7.00	2.80	2.20	3.80	3.00	7.00	2.40	1.75	1.90	6.50
30		6.00	2.70	2.20	4.00	2.50	5.50	2.20	1.75	1.90	13.00
31		6.30	.....	3.50	.....	2.20	3.80	.....	1.70	.....	15.50

OCONEE RIVER NEAR DUBLIN, GA.

This station was established by the United States Weather Bureau in 1894, was discontinued on April 30, 1897, and was reestablished by the Georgia geological survey on February 11, 1895. Since October, 1898, the station has been maintained by the United States Weather Bureau. It is described in Water-Supply Paper No. 48, page 152. Results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 164. During 1901 the following measurements were made by F. A. Murray and K. T. Thomas:

February 20: Gage height, 5 feet; discharge, 5,341 second-feet.
May 7: Gage height, 3.40 feet; discharge, 3,949 second-feet.
November 7: Gage height, 1 foot; discharge, 2,334 second-feet.

Daily gage height, in feet, of Oconee River near Dublin, Ga., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	9.80	4.70	4.60	16.40	3.70	4.00	6.10	1.50	10.30	4.00	.80	1.00
2	10.40	6.10	4.20	16.10	3.50	6.30	6.50	1.40	10.50	4.30	.80	1.00
3	11.30	5.60	3.90	16.50	3.30	7.00	6.00	1.20	10.30	4.50	.80	1.00
4	12.50	6.70	3.70	16.60	3.00	7.50	5.80	1.20	9.40	5.10	.80	1.30
5	13.00	8.60	3.40	20.50	2.90	6.00	4.30	.80	6.30	4.80	.80	1.60
6	13.90	9.30	3.20	22.60	2.70	5.00	3.00	.50	3.40	3.90	.96	2.50
7	13.90	11.00	3.00	21.30	2.50	5.30	2.80	1.40	2.30	2.80	1.10	2.20
8	13.00	14.30	2.90	19.50	2.90	7.50	2.00	4.00	2.00	2.10	1.00	1.80
9	10.80	15.60	2.80	17.40	2.80	8.10	1.80	4.40	1.70	2.00	1.00	1.60
10	7.40	15.80	2.80	15.00	2.60	9.50	1.70	4.50	1.30	1.60	1.00	1.50
11	6.00	14.60	4.50	12.00	2.40	8.40	2.10	2.90	1.20	1.70	.90	1.50
12	5.40	13.80	5.50	8.20	2.10	7.50	2.10	1.70	1.00	1.70	.90	2.00
13	6.00	13.40	6.60	6.00	2.00	4.90	2.00	3.40	.80	1.60	.90	2.00
14	6.60	12.50	8.00	7.00	1.80	7.70	1.90	4.30	.70	2.00	.90	1.70
15	7.40	10.20	8.20	8.00	1.80	9.10	1.80	4.00	.60	2.50	.80	2.00
16	8.00	8.90	6.20	8.90	2.00	10.40	1.50	4.50	1.40	2.00	.90	5.50
17	8.60	6.80	5.10	9.60	2.20	11.20	2.40	4.50	1.40	1.70	.96	6.80
18	9.10	5.90	4.60	10.00	1.80	11.40	2.70	5.20	4.00	1.40	.90	7.40
19	9.60	5.40	4.20	9.80	1.70	11.30	2.50	6.50	11.40	1.30	.90	8.30
20	9.90	5.10	3.70	9.00	2.00	10.80	3.30	7.40	14.50	1.30	1.10	8.00
21	10.30	4.70	4.70	8.10	3.60	9.70	5.90	8.00	17.80	1.20	1.40	4.50
22	6.60	4.50	4.80	8.00	6.00	7.60	7.00	7.80	19.40	1.00	1.50	3.00
23	6.60	4.20	4.00	7.60	7.50	5.30	7.60	7.50	18.00	1.00	1.70	2.50
24	5.30	4.50	4.10	6.80	7.80	4.10	7.20	7.50	16.40	1.00	1.60	2.60
25	4.60	4.90	4.30	6.20	8.10	3.70	3.50	7.30	13.80	.90	1.40	3.00
26	4.80	4.90	4.80	5.00	6.60	4.50	2.90	7.20	8.30	.90	1.30	3.60
27	4.70	5.00	7.50	4.60	4.50	4.10	1.50	7.80	4.00	.90	1.30	3.70
28	5.00	5.20	9.30	4.10	4.60	6.30	1.40	8.60	3.10	.80	1.30	3.80
29	5.10	.....	12.00	3.80	3.90	6.00	3.00	9.60	3.80	.80	1.20	6.00
30	5.60	.....	15.10	3.80	3.10	5.50	2.30	10.00	4.10	.70	1.10	7.60
31	5.10	.....	16.50	.....	2.80	.....	1.80	10.30	.....	.80	.....	8.60

ALCOVY RIVER NEAR COVINGTON, GA.

This station was established on April 30, 1901. It is located about 3 miles east of Covington, at a low wooden bridge which is often under water. The gage is a vertical rod 10 feet long, graded to feet and tenths, marked by tacks and brass figures. It is spiked to a birch tree on left bank of river, 2 feet from upstream side of bridge.

The banks are low and easy to overflow. The ground on the right bank is low and swampy for several hundred yards and becomes flooded by a moderate rise. The following discharge measurements were made during 1901 by Max Hall and F. A. Murray:

April 30: Gage height, 3 feet; discharge, 307 second-feet.
June 14: Gage height, 3.12 feet; discharge, 353 second-feet.
August 8: Gage height, 3.64 feet; discharge, 376 second-feet.
October 26: Gage height, 2 feet; discharge, 162 second-feet.

Daily gage height, in feet, of Alcovy River near Covington, Ga., for 1901.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	2.90	4.20	4.00	1.60	5.60	3.00	2.00	2.10
2	.....	2.80	4.30	3.40	1.50	4.50	4.30	2.00	2.00
3	.....	2.80	4.00	2.80	1.40	3.70	4.30	2.00	2.80
4	.....	2.70	3.30	2.60	1.60	3.00	4.20	2.00	3.20
5	.....	2.70	3.00	2.40	1.60	2.80	3.20	2.30	3.00
6	.....	2.70	2.70	2.20	4.30	2.50	2.90	2.10	2.70
7	.....	2.80	4.50	2.00	5.10	2.40	2.50	2.10	2.50
8	.....	2.60	4.00	1.90	4.00	2.20	2.30	2.10	2.50
9	.....	2.50	3.20	1.90	2.50	2.00	2.30	2.00	2.40
10	.....	2.40	2.60	1.80	2.10	2.00	2.30	2.10	2.90
11	.....	2.40	2.40	2.00	5.20	2.00	2.30	2.10	3.00
12	.....	2.30	2.30	2.50	5.00	2.00	2.30	2.10	2.70
13	.....	2.30	2.50	3.10	4.00	1.90	2.50	2.10	2.50
14	.....	2.40	3.10	3.90	3.50	2.00	2.40	2.10	2.50
15	.....	2.30	3.30	4.60	4.80	2.10	2.40	2.06	5.20
16	.....	2.20	3.80	4.30	6.10	2.00	2.30	2.00	5.30
17	.....	2.10	4.30	4.00	5.90	5.60	2.10	2.00	4.50
18	.....	2.00	4.80	3.80	5.50	6.30	2.00	2.10	4.20
19	.....	2.00	5.70	3.30	5.30	5.90	2.00	2.10	3.00
20	.....	2.50	5.30	4.00	4.60	6.00	2.00	2.50	2.80
21	.....	3.40	5.00	4.80	5.60	5.30	1.90	2.80	2.40
22	.....	4.50	3.60	5.30	5.60	3.90	1.90	2.60	2.80
23	.....	4.20	2.90	5.80	6.80	3.20	1.90	2.40	2.80
24	.....	3.70	2.60	5.00	6.20	2.90	2.00	2.40	3.00
25	.....	3.20	2.40	4.20	5.00	2.80	2.00	2.30	3.20
26	.....	2.90	2.80	3.70	4.50	2.60	2.00	2.30	3.30
27	.....	2.80	4.50	3.20	4.00	2.50	2.00	2.20	3.10
28	.....	2.70	5.10	2.70	4.70	2.40	2.00	2.10	3.80
29	.....	2.50	4.90	2.50	6.20	2.40	2.00	2.10	5.40
30	3.00	2.40	3.60	2.00	6.00	2.50	2.00	2.10	6.90
31	.....	3.30	.....	2.40	4.90	.....	2.00	.....	7.40

YELLOW RIVER AT ALMON, GA.

This station, which was established September 12, 1897, is described in Water-Supply Paper No. 48, page 153. The results of measurements at this point for 1900 will be found in the Twenty-second Annual Report, Part IV, page 165. Observations were discontinued on December 31, 1901. The following measurements of discharge were made during 1901 by Max Hall and F. A. Murray:

List of discharge measurements of Yellow River at Almon, Ga.

Date.	Hydrographer.	Gage height.	Discharge.
1901.		*Feet.*	*Sec. ft.*
January 29	Max Hall	3.40	541
April 3	do	13.80	4,536
June 14	do	3.80	610
August 8	F. A. Murray	2.58	283
October 26	Max Hall	2.33	253

Daily gage height, in feet, of Yellow River at Almon, Ga., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	6.00	3.40	3.20	6.00	3.20	5.00	3.20	2.40	5.50	3.00	2.20	2.40
2	5.50	3.40	3.20	11.00	3.10	4.10	3.00	2.30	4.20	4.50	2.20	2.40
3	6.00	10.00	3.10	13.90	3.00	3.50	2.90	2.20	3.10	4.30	2.40	3.00
4	5.00	15.00	3.10	8.80	3.00	3.40	2.80	2.20	3.40	4.00	2.40	2.90
5	4.30	12.00	3.10	5.50	3.00	3.30	2.70	2.10	3.40	3.20	2.40	2.80
6	4.00	5.50	3.00	5.00	3.00	3.20	2.60	2.80	3.10	3.00	2.40	2.70
7	3.80	5.50	3.00	4.50	3.00	4.40	2.50	3.00	3.00	3.00	2.40	2.70
8	3.70	5.80	3.00	4.00	2.90	3.50	2.40	2.80	2.90	3.00	2.40	2.80
9	3.50	6.30	3.00	3.90	2.90	3.40	2.30	2.50	2.90	3.00	2.40	2.80
10	3.40	5.40	3.00	3.80	2.80	3.30	2.20	2.40	2.80	3.00	2.40	2.80
11	5.00	4.60	4.50	3.70	2.80	3.20	2.40	2.80	2.80	3.00	2.40	2.80
12	10.00	4.40	4.00	3.70	2.80	3.00	2.30	4.20	2.80	3.00	2.40	2.80
13	10.00	4.00	3.50	4.00	2.70	3.40	2.20	3.40	2.80	2.80	2.40	2.80
14	5.50	3.90	3.00	9.50	2.70	3.60	2.20	2.80	2.80	2.80	2.40	2.80
15	4.50	3.70	2.90	8.40	2.70	6.70	2.80	3.80	2.80	2.70	2.40	6.00
16	4.20	3.50	2.80	5.20	2.60	7.00	3.00	7.00	2.80	2.70	2.40	4.80
17	4.00	3.40	2.80	5.00	2.60	4.80	3.80	7.50	3.50	2.70	3.00	3.20
18	4.00	3.40	2.80	4.00	2.80	7.00	3.40	4.80	9.00	2.70	3.00	3.00
19	3.80	3.40	2.80	5.10	2.80	6.10	10.00	3.50	10.00	2.70	3.00	2.80
20	3.80	3.40	2.80	5.40	2.80	4.10	7.00	6.00	4.80	2.70	3.00	2.80
21	3.50	3.30	2.80	4.50	5.00	3.20	3.40	3.90	3.00	2.70	3.00	2.80
22	3.50	3.20	2.80	4.00	7.50	3.20	3.20	6.00	3.60	2.60	3.00	2.80
23	3.40	3.20	2.80	3.90	6.10	3.10	2.90	10.00	3.60	2.60	3.00	3.00
24	3.80	3.20	5.40	3.80	4.20	3.00	2.80	8.00	3.40	2.60	3.00	3.00
25	4.00	3.40	6.00	3.70	3.60	3.00	2.70	4.70	3.20	2.50	2.80	3.00
26	3.50	3.20	7.00	3.60	3.40	4.00	2.60	3.80	3.20	2.50	2.70	3.00
27	3.40	3.20	10.00	3.50	3.30	4.20	2.40	5.00	3.00	2.50	2.60	3.00
28	3.40	3.20	7.00	3.50	3.20	3.30	2.30	9.00	3.00	2.50	2.50	3.00
29	3.40	.....	5.00	3.40	3.00	3.10	2.20	10.00	3.00	2.50	2.40	10.00
30	4.00	.....	4.00	3.30	2.90	3.10	2.70	4.80	3.00	2.40	2.40	20.00
31	3.50	.....	3.00	.....	5.20	.....	2.50	4.00	.....	2.30	.....	15.00

OCMULGEE RIVER NEAR FLOVILLA, GA.

A station was established July 26, 1901, on Ocmulgee River at Lamars Ferry, one-half mile below Lamar's mill and 5 miles east of Flovilla, Ga. The object of this station is to compare the discharge of the river at this point with its discharge below at Macon through the low-water season.

The gage consists of a ¾ by 5 inch by 10-foot poplar board graduated to feet and tenths with brass figures, staples, and tacks. The rod is nailed to a 16-foot pine plank, which is spiked to an ash tree 25 feet below the ferry landing. The tree is graduated with nails 1 foot apart, extending the gage up to 20 feet above datum.

The observer is Van White. The following discharge measurements were made during 1901 by F. A. Murray and K. T. Thomas:

July 26: Gage height, 2.93 feet; discharge, 1,035 second-feet.
September 12: Gage height, 3.10 feet; discharge, 1,087 second-feet.
November 5: Gage height, 2.90 feet; discharge, 948 second-feet.

Daily gage height, in feet, of Ocmulgee River near Florilla, Ga., for 1901.

Date.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1		3.00	7.90	3.50	2.70	2.80
2		2.70	6.70	5.90	2.80	2.70
3		2.60	4.50	6.50	2.80	3.80
4		2.50	4.10	5.10	2.80	4.20
5		2.70	3.70	4.00	2.80	3.70
6		6.00	3.60	3.60	2.80	3.40
7		6.50	3.40	3.40	2.80	3.60
8		5.00	3.30	3.30	2.80	3.20
9		3.90	3.20	3.20	2.80	3.10
0		2.20	3.10	3.20	2.80	3.40
1		10.50	3.10	3.20	2.80	3.80
2		5.20	3.10	3.10	2.80	3.60
3		5.30	3.00	3.50	2.80	3.40
4		4.00	4.00	3.40	2.80	3.30
5		4.50	3.50	3.20	2.80	10.20
6		12.40	3.20	3.00	2.70	6.80
7		10.00	7.50	3.00	2.70	5.30
8		2.90	17.40	3.00	2.70	4.50
9		6.90	13.80	2.90	2.70	4.00
20		5.00	9.00	2.90	3.20	3.70
21		5.40	6.80	2.90	3.20	3.50
22		9.00	6.00	2.90	3.10	3.20
23		16.00	5.70	2.90	3.00	3.60
24		16.50	5.30	2.90	3.00	4.20
25		7.00	4.90	2.80	3.00	4.20
26	2.90	6.10	4.20	2.70	2.90	4.40
27	2.80	8.70	3.50	2.80	2.90	4.60
28	3.50	9.70	3.50	2.80	2.80	9.60
29	3.10	8.90	4.00	2.80	2.80	21.20
30	3.60	7.10	4.60	2.80	2.80	24.00
31	3.40	5.80	.....	2.80	.....	18.00

MISCELLANEOUS DISCHARGE MEASUREMENTS MADE IN ALTAMAHA RIVER BASIN.

Date.	Stream.	Locality.	Discharge.
1901.			*Sec. ft.*
February 20	Oconee River	Willis Ferry, Ga	1,455
August 1	do	Near Harmony Grove, Ga	85
April 26	Camp Creek	Near McDonough, Ga	11
Do	do	do	11
Do	Long Branch Creek	do	2
Do	Camp Creek	do	9
September 13	Ocmulgee River	Berner, Ga	1,005

TOWALIGA RIVER NEAR JULIETTE, GA.

This station was established on the Southern Railroad bridge 2½ miles north of Juliette, Ga., May 5, 1899. It is described in Water-Supply Paper No. 48, page 154. The results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 166. The station was discontinued on December 31, 1901. The

following measurements were made during 1901 by F. A. Murray and K. T. Thomas:

List of discharge measurements of Towaliga River near Juliette, Ga.

Date.	Hydrographer.	Gage height.	Discharge.
1901.		*Feet.*	*Sec. ft.*
January 14	K. T. Thomas	3.75	563
February 22	F. A. Murray	2.70	362
May 8	do	2.22	301
July 27	do	1.48	172
September 13	do	1.55	163
September 22	do	2.63	312
November 5	K. T. Thomas	1.65	185

Daily gage height, in feet, of Towaliga River near Juliette, Ga., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	5.10	2.80	2.70	8.80	2.50	5.60	2.00	2.00	3.40	2.60	1.50	1.70
2	5.90	3.00	2.70	11.70	2.40	3.70	3.00	3.00	2.50	2.60	1.50	1.70
3	7.20	3.40	2.60	13.90	2.40	2.80	2.20	1.70	2.10	3.00	1.60	1.70
4	5.40	8.30	2.50	12.00	2.30	2.50	2.00	1.60	2.00	2.20	1.60	2.00
5	4.80	8.80	2.50	5.60	2.30	2.30	2.00	1.50	1.80	2.00	1.50	2.50
6	4.30	4.60	2.50	4.70	2.30	2.30	1.80	1.40	1.50	2.00	1.50	2.40
7	4.10	3.50	2.40	4.20	2.20	5.00	2.20	2.60	1.50	2.00	1.50	2.00
8	4.30	5.20	2.40	3.90	2.10	3.80	1.80	2.40	1.50	1.90	1.50	1.80
9	3.90	5.90	2.40	3.50	2.10	2.40	9.20	1.90	1.40	1.80	1.50	1.80
10	3.90	6.00	4.10	3.40	2.10	2.20	2.80	1.80	1.40	1.80	1.50	2.00
11	3.50	5.80	4.10	3.30	2.10	2.20	2.40	4.60	1.50	1.80	1.50	2.00
12	5.10	4.60	2.90	3.20	2.10	2.10	2.20	3.40	1.50	2.00	1.40	2.00
13	5.80	3.60	3.40	4.30	2.10	3.60	2.00	3.10	1.50	1.70	1.40	2.00
14	4.30	3.30	3.10	4.60	2.10	4.00	2.00	2.40	1.80	1.70	1.40	2.00
15	2.90	3.00	3.10	4.00	2.10	5.00	2.00	4.30	1.60	1.70	1.40	7.00
16	2.50	3.00	2.60	3.60	2.10	5.60	2.10	6.10	1.50	1.70	1.40	6.40
17	7.10	2.90	2.90	3.20	2.10	4.50	2.10	11.20	12.20	1.70	1.50	5.30
18	5.80	2.80	2.80	3.10	2.10	3.30	2.00	4.20	7.60	1.70	1.40	2.80
19	3.60	2.70	2.70	4.60	2.10	2.50	9.10	3.10	3.60	1.70	2.00	2.50
20	3.30	2.70	2.50	4.00	2.60	2.30	3.50	4.20	3.00	1.60	2.40	2.30
21	3.10	2.70	2.90	3.40	3.50	2.20	1.80	3.10	3.00	1.50	2.30	2.10
22	3.00	2.60	2.60	3.10	7.60	2.20	1.60	2.60	2.70	1.50	2.10	2.30
23	2.80	2.80	2.40	2.90	7.10	3.00	1.50	5.90	2.40	1.50	1.70	2.20
24	2.80	3.00	2.90	2.90	3.50	4.50	2.60	9.00	2.30	1.50	1.70	2.60
25	3.00	3.00	3.10	2.80	3.40	3.40	2.20	4.60	2.10	1.50	1.70	2.30
26	2.80	3.00	6.30	2.80	2.80	2.20	1.50	4.50	1.80	1.50	1.70	2.10
27	3.00	3.00	11.60	2.80	2.50	2.30	1.40	3.40	1.80	1.50	1.70	3.10
28	2.80	2.70	5.30	2.70	2.50	2.30	1.30	2.40	2.00	1.50	1.70	6.40
29	3.00	.....	4.00	2.70	2.40	2.10	1.80	4.50	3.40	1.50	1.70	11.00
30	3.00	.....	3.60	2.70	2.30	2.00	2.40	3.10	3.00	1.50	1.70	8.50
31	2.80	.....	9.20	.....	4.80	.....	2.00	2.60	.....	1.50	.....	6.40

OCMULGEE RIVER AT MACON, GA.

This station was established by the United States Weather Bureau January 21, 1893, and measurements were begun by the United States Geological Survey in 1895. The station is described in Water-Supply Paper No. 48, page 155. Records of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 172. Dur-

ing 1901 the following measurements were made by F. A. Murray and others:

List of discharge measurements of Ocmulgee River at Macon, Ga.

Date.	Hydrographer.	Gage height.	Discharge.
1901.		*Feet.*	*Sec. feet.*
January 2	Max Hall	12.32	8,662
February 21	F. A. Murray	4.35	2,495
April 19	do	6.60	3,724
May 8	do	3.75	1,958
November 6	K. T. Thomas	2.15	1,107
November 8	do	2.15	1,141

Daily gage height, in feet, of Ocmulgee River at Macon, Ga., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	11.70	4.70	4.10	14.50	4.20	9.90	5.30	3.80	5.40	3.40	1.70	1.90
2	12.30	5.00	4.00	9.50	4.10	8.50	5.50	3.00	7.50	3.30	1.70	1.90
3	13.70	4.50	3.90	18.80	4.00	6.20	5.70	2.50	4.80	5.30	1.70	2.00
4	11.90	14.90	3.80	17.30	3.90	5.40	3.80	2.20	4.40	5.60	1.70	1.90
5	9.50	15.90	3.80	13.10	3.90	5.10	3.20	2.20	3.40	3.90	2.00	3.20
6	7.70	13.70	3.70	10.50	4.00	4.30	3.00	3.80	3.10	3.30	2.00	2.70
7	6.50	10.10	3.50	9.00	3.90	4.70	2.90	9.40	3.00	3.00	2.10	2.40
8	5.70	8.70	3.40	7.70	3.80	6.80	3.20	7.40	2.80	2.80	2.00	2.40
9	5.10	12.10	3.40	6.70	3.70	5.30	3.10	4.40	2.60	2.70	1.90	2.30
10	4.80	11.30	3.50	6.10	3.60	4.00	3.00	3.00	2.50	2.60	2.00	2.40
11	4.60	9.50	5.80	5.70	3.50	3.50	3.80	3.80	2.40	2.60	2.00	3.10
12	5.80	7.90	6.90	5.40	3.40	3.30	2.90	8.20	2.40	2.50	1.90	2.90
13	12.60	7.40	5.40	5.60	3.40	3.80	2.70	5.00	2.30	3.00	1.90	2.50
14	12.00	6.50	5.00	8.50	3.50	6.00	2.60	4.40	2.60	2.90	2.00	2.30
15	8.60	5.80	4.20	10.40	3.50	6.90	2.50	3.40	3.20	2.80	2.10	13.70
16	7.20	5.40	3.80	10.20	3.30	9.60	3.70	5.90	2.90	2.60	2.00	11.90
17	11.40	5.10	3.60	8.30	3.20	8.80	4.00	14.60	5.00	2.50	1.90	7.50
18	11.20	4.96	3.40	6.80	3.10	7.50	3.50	11.60	17.70	2.30	1.90	4.70
19	7.80	4.70	3.40	6.50	3.00	9.20	4.00	7.40	16.20	2.20	2.00	3.70
20	6.10	4.60	3.30	7.70	3.30	6.60	15.40	7.00	12.00	2.00	2.20	3.20
21	4.30	4.40	3.70	7.80	5.50	5.20	8.50	7.80	7.80	1.90	2.40	2.70
22	5.00	4.20	3.90	6.50	12.00	4.60	5.50	5.20	6.00	2.10	2.50	2.10
23	4.50	4.20	3.60	5.80	13.90	5.10	4.00	10.00	4.70	2.00	2.30	2.30
24	4.40	4.40	3.80	5.50	9.20	5.30	3.50	14.40	3.90	2.00	2.20	3.10
25	4.80	4.50	4.40	5.20	5.70	4.70	2.80	12.00	3.50	1.90	2.20	3.40
26	5.10	4.60	16.10	5.00	5.00	3.30	2.60	7.20	3.30	1.90	2.10	3.40
27	4.50	4.60	16.10	4.80	5.30	5.30	2.50	4.80	3.10	1.90	2.00	3.70
28	5.00	4.40	13.20	4.60	4.70	5.10	2.90	10.00	3.10	1.80	2.00	4.90
29	5.10	.....	9.40	4.50	4.10	4.30	3.10	10.40	3.70	1.80	1.90	13.60
30	4.50	.....	7.20	4.30	3.80	5.40	3.10	9.60	3.90	1.70	1.90	17.10
31	5.30	.....	15.80	.....	4.70	.....	3.00	7.40	.....	1.70	.....	17.90

EASTERN GULF DRAINAGE.

FLINT RIVER AT WOODBURY, GA.

Measurements of the flow of Flint River were made during 1897 and 1898 at Molina Ga., but the river bed was so shifting that the station was discontinued on June 2, 1898. Results of measurements made at Molina will be found as follows: For 1897, Nineteenth Annual Report, Part IV, page 234; for 1898, Twentieth Annual Report, Part IV, page 233. On March 29, 1900, a gage was put in at the Macon and Birmingham bridge, near Woodbury, Ga., 5 miles below the Molina station. This gage was maintained by the Georgia geological survey until November 1, 1900, when it was adopted by the United States Weather Bureau as a half-year station, instead of the one at Reynolds, Ga. The station is described in Water-Supply Paper No. 48,

page 157. Results of measurements for 1900 will be found in the Twenty-Second Annual Report, Part IV, page 190. During 1901 the following measurements were made by F. A. Murray and Max Hall:

List of discharge measurements of Flint River at Woodbury, Ga.

Date.	Hydrographer.	Gage height.	Discharge.
1901.		*Feet.*	*Sec. feet.*
February 4	F. A. Murray	4.02	4,901
March 5	do	1.18	985
May 17	do	.82	565
August 15	do	.90	813
September 6	Max Hall	.60	582

Daily gage height, in feet, of Flint River at Woodbury, Ga., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.70	1.70	1.30	5.00	1.10	2.70	2.10	0.80	1.00	0.90	0.40	0.60
2	3.70	1.60	1.20	4.40	1.00	3.00	1.60	.70	1.10	1.40	.50	.70
3	4.70	1.50	1.20	7.60	1.00	2.80	1.50	.70	.90	2.70	.50	.90
4	4.40	3.70	1.20	6.40	1.00	2.50	1.20	.50	.80	1.70	.60	1.00
5	3.50	4.80	1.10	5.20	.90	1.90	.90	.40	.60	1.10	.50	1.10
6	2.60	5.40	1.10	3.70	.90	1.60	.90	1.00	.60	1.10	.50	.90
7	2.10	4.30	1.00	2.60	.80	1.80	1.60	1.50	.50	.80	.60	.80
8	1.80	3.00	1.00	2.10	.90	2.60	1.10	1.20	.50	.70	.60	.70
9	1.60	3.40	1.00	1.80	.80	3.20	1.10	.90	.50	.60	.50	.80
10	1.50	3.30	1.20	1.60	.80	1.80	1.00	.70	.40	.70	.50	.70
11	1.60	2.80	2.00	1.50	.70	1.40	.80	.60	.40	.60	.60	1.10
12	3.30	2.40	1.80	1.40	.70	1.10	.60	.80	.40	.60	.50	1.00
13	4.20	2.20	1.50	1.60	.80	1.20	.50	.90	.50	.50	.60	.90
14	4.50	2.00	1.40	2.10	1.00	2.10	.40	.70	.80	.70	.60	.80
15	3.90	1.70	1.20	2.00	1.10	1.80	.40	.90	1.00	.60	.60	.90
16	2.90	1.60	1.10	1.90	.90	1.70	.60	1.80	1.20	.50	.50	3.10
17	4.20	1.50	1.00	1.70	.80	1.60	.80	3.00	.90	.60	.60	2.20
18	3.40	1.40	1.00	1.60	.90	1.50	1.00	2.50	3.40	.50	.50	1.50
19	2.30	1.40	1.00	2.80	.80	1.20	1.40	2.00	4.60	.50	.60	1.20
20	2.00	1.30	1.10	2.90	1.20	1.10	.90	1.70	4.80	.40	.70	1.00
21	1.70	1.30	1.20	2.70	3.10	.90	.90	1.90	3.10	.40	.80	.80
22	1.60	1.30	1.20	2.30	9.00	.80	.80	2.50	1.90	.50	.80	.70
23	1.50	1.40	1.10	1.90	10.00	1.20	.80	6.10	1.20	.50	.70	.80
24	1.40	1.50	1.60	1.70	8.00	1.40	.50	8.00	.90	.40	.60	1.10
25	1.70	1.50	1.70	1.40	5.00	1.00	.40	7.00	.80	.50	.50	1.20
26	1.60	1.60	4.20	1.30	2.80	.80	.40	5.60	.70	.40	.60	1.30
27	1.50	1.50	4.90	1.30	2.00	.70	.40	3.20	.70	.40	.70	1.20
28	1.60	1.40	3.60	1.20	1.60	1.00	.50	4.10	.80	.50	.60	1.50
29	1.60	.....	2.80	1.20	1.40	1.30	.70	2.90	.80	.40	.50	6.20
30	1.50	.....	2.10	1.10	1.30	1.50	.70	2.00	1.00	.40	.60	10.60
31	1.80	.....	5.60	.....	1.70	.....	.60	1.30	.....	.30	.....	10.00

FLINT RIVER AT ALBANY, GA.

This station, which is described in Water-Supply Paper No. 48, page 156, was originally established by the United States Weather Bureau on April 10, 1893, and has been maintained from that date to the present time. The present rod is located at the foot of Broad street, just below the county bridge. The station is described in Water-Supply Paper No. 48, page 156. The following measurements were made during 1901 by B. M. Hall and F. A. Murray:

March 9: Gage height, 4 feet; discharge, 5,364 second-feet.
March 26: Gage height, 7.30 feet; discharge, 10,682 second-feet.
April 18: Gage height, 7.95 feet; discharge 10,715 second-feet.
July 19: Gage height, 1.88 feet; discharge, 4,256 second-feet.

Daily gage height, in feet, of Flint River at Albany, Ga., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	14.00	4.90	6.10	19.20	5.20	8.90	2.50	0.70	9.80	5.60	4.10	4.00
2	15.90	5.70	6.30	20.10	4.90	9.40	2.90	.90	10.00	7.20	4.00	3.80
3	17.60	6.90	6.50	20.90	4.30	9.80	2.50	1.30	9.50	7.80	4.00	3.60
4	18.10	7.10	6.90	21.60	4.10	10.40	2.30	1.60	9.40	8.40	4.00	3.40
5	18.00	8.00	6.10	21.80	3.20	10.90	2.60	1.90	9.20	8.40	4.30	3.20
6	17.10	8.40	5.20	21.40	3.00	11.20	3.10	2.30	9.20	7.60	4.40	3.20
7	16.80	8.70	4.30	21.20	3.00	11.00	3.70	2.30	8.80	7.40	4.50	3.80
8	17.20	9.80	4.10	21.00	2.30	11.00	4.10	2.30	8.20	7.10	4.20	3.90
9	15.00	10.90	4.30	20.30	2.20	10.30	4.80	2.80	8.20	6.40	4.10	4.10
10	14.20	12.30	4.90	19.70	2.40	9.60	4.50	3.00	8.00	5.80	3.80	3.70
11	13.10	14.00	5.20	19.10	2.60	8.40	3.90	3.20	7.60	5.40	3.60	3.50
12	9.30	14.40	5.90	18.20	2.50	8.90	3.20	3.20	7.10	4.20	3.30	3.30
13	8.10	14.90	6.30	18.00	2.30	9.80	2.80	3.00	7.10	3.80	3.30	3.10
14	8.10	15.30	6.90	18.00	1.90	10.30	2.30	3.00	7.20	2.90	3.30	2.90
15	8.00	14.10	7.20	17.10	1.90	10.80	1.90	3.40	7.40	2.80	3.10	2.90
16	7.80	13.70	7.80	16.13	1.80	10.10	1.80	3.80	7.60	2.50	2.60	3.80
17	6.90	12.10	7.60	15.80	2.10	9.30	1.70	4.60	8.90	1.80	2.40	4.10
18	6.50	10.40	7.40	12.40	2.40	9.60	1.70	5.40	12.80	1.90	1.90	5.80
19	6.20	9.10	7.60	11.10	2.70	9.60	1.90	5.80	16.90	1.70	1.60	5.90
20	6.00	9.70	7.90	11.60	3.60	9.10	2.40	6.40	21.00	1.60	1.20	6.40
21	5.80	10.10	8.30	11.90	3.70	8.30	2.60	6.80	25.00	1.40	.90	6.90
22	5.50	9.30	7.90	11.90	3.90	7.10	2.80	7.70	25.20	1.30	.70	7.20
23	5.50	8.00	7.60	10.80	4.10	7.10	3.20	8.40	24.60	1.30	.90	8.10
24	5.50	8.70	7.60	9.70	4.30	6.20	4.10	8.60	22.10	.90	1.40	8.60
25	5.40	8.90	7.20	8.40	4.50	4.90	4.10	8.60	19.40	.90	1.70	9.10
26	5.00	7.60	8.10	7.60	4.90	3.40	3.60	9.10	15.80	1.20	2.10	9.10
27	5.00	7.10	10.40	6.90	5.30	3.10	3.10	9.10	13.20	1.50	2.40	8.90
28	4.80	6.20	11.50	6.90	6.10	2.30	2.30	9.40	9.60	1.90	2.70	7.40
29	4.40	.....	13.30	6.10	6.50	2.10	1.60	9.40	7.40	2.40	3.80	7.20
30	4.20	.....	15.10	5.30	7.30	2.30	1.20	9.50	6.10	3.60	4.10	6.90
31	4.00	.....	17.00	.....	8.60	.....	.90	9.60	.....	3.90	.....	6.40

CHATTAHOOCHEE RIVER NEAR GAINESVILLE, GA.

This station was established June 26, 1901, and is 3½ miles northwest of Gainesville, at Thompson's bridge.

The gage is a 15-foot vertical rod, graduated to feet and tenths, marked with brass figures and staples. It is fastened to a small tree on the right bank, about 50 feet below the bridge, which is a three-span wooden structure supported on stone piers. At low water nearly the whole of the river flows through the center span, which is 100 feet long. The bridge is entirely housed in, but holes are cut in the floor along the upstream side at intervals of 12 feet, through which the meter can be lowered for gaging.

The bench mark is the top of the main bridge stringer at the left side of the first stone pier in river from left bank, and is 31 feet above datum.

The observer is H. D. Thompson. The following discharge measurements were made during 1901:

July 16: Gage height, 5.73 feet; discharge, 2,777 second-feet.
October 25: Gage height, 3 feet; discharge, 993 second-feet.

Daily gage height, in feet, of Chattahoochee River near Gainesville, Ga., for 1901.

Day.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	3.80	2.80	5.10	4.00	3.00	2.30
2	.....	3.60	2.80	5.00	3.90	3.00	2.30
3	.....	3.50	2.80	4.60	3.70	2.90	2.30
4	.....	3.40	2.70	4.50	3.50	2.90	2.40
5	.....	3.20	12.00	4.10	4.00	2.90	2.40
6	.....	3.30	8.50	4.00	4.10	3.00	2.40
7	.....	3.20	5.20	3.90	4.00	3.00	2.60
8	.....	3.40	5.00	3.70	3.90	2.80	2.80
9	.....	3.20	3.20	4.10	3.90	2.80	3.60
10	.....	3.20	4.80	4.00	3.70	2.80	4.60
11	.....	3.10	4.80	5.50	3.80	2.80	4.30
12	.....	3.00	2.90	5.00	3.60	2.70	4.10
13	.....	3.00	3.60	4.20	3.60	2.70	4.00
14	.....	3.10	3.20	3.80	3.50	2.70	4.00
15	.....	3.10	2.80	3.50	3.60	2.60	3.90
16	.....	6.50	5.60	3.90	3.50	2.60	3.40
17	.....	4.50	6.80	11.00	3.40	2.50	3.80
18	.....	5.50	5.80	6.00	3.40	2.50	3.60
19	.....	8.60	3.50	4.60	3.40	2.40	3.70
20	.....	5.90	4.80	4.20	3.40	2.80	3.90
21	.....	5.00	6.50	3.80	3.30	2.70	4.60
22	.....	4.90	12.00	3.40	3.30	2.50	4.20
23	.....	3.80	15.00	3.20	3.20	2.50	4.00
24	.....	3.10	6.50	3.80	3.00	2.80	4.60
25	.....	3.00	5.60	3.70	3.10	2.70	4.40
26	4.00	2.80	6.00	3.50	3.10	2.50	4.20
27	8.60	3.20	5.00	4.00	3.10	2.40	5.60
28	5.10	3.00	5.50	3.80	3.10	2.40	9.60
29	4.20	3.10	7.00	3.90	3.10	2.36	28.40
30	5.60	2.80	6.50	3.80	3.00	2.20	12.60
31	.....	3.00	6.00	.....	3.00	.....	8.40

CHATTAHOOCHEE RIVER NEAR BUFORD, GA.

This station, which was established June 24, 1901, is at Strickland Bridge, 6 miles west of Buford, Ga. The bridge consists of a single iron span 204 feet long.

A wire gage is fastened to the guard rail of the bridge on the upstream side. The pulley is 40 feet from the left-bank end of the bridge, which is the initial point for soundings. The bench mark is the top of the bridge floor at upstream end of second iron crossbeam from left bank, and its elevation is 33 feet above datum.

The station was discontinued on December 31, 1901, for want of a competent gage reader.

The following discharge measurements were made during 1901:

List of discharge measurements of Chattahoochee River near Buford, Ga.

Date.	Hydrographer.	Gage height.	Discharge.
1901.		*Feet.*	*Sec.-ft.*
April 12	F. A. Murray	3.40	2,310
June 24	do	3.47	2,559
July 17	do	5.38	3,893
August 6	do	6.90	5,758
October 24	Max Hall	2.46	1,638

Daily gage height, in feet, of Chattahoochee River near Buford, Ga., for 1901.

Day.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	3.90	2.40	5.50	3.40	2.30	2.10
2	.....	3.70	2.20	4.80	4.30	2.30	2.10
3	.....	3.40	2.10	4.50	3.10	2.30	2.50
4	.....	3.20	2.10	4.20	3.00	2.30	2.30
5	.....	3.00	2.20	4.00	2.90	2.40	2.40
6	.....	2.90	2.10	3.90	2.80	2.40	2.30
7	.....	3.10	3.30	3.80	2.80	2.30	2.30
8	.....	3.70	4.90	3.70	2.80	2.30	2.20
9	.....	3.20	3.60	3.50	2.80	2.20	2.30
10	.....	2.80	3.10	3.50	2.80	2.20	2.60
11	.....	2.70	3.50	4.10	2.80	2.20	3.40
12	.....	2.50	3.40	3.90	2.70	2.20	2.60
13	.....	2.60	3.30	3.50	3.10	2.40	2.40
14	.....	2.60	3.30	3.50	2.80	2.30	2.60
15	.....	2.80	7.90	3.40	2.70	2.20	11.00
16	.....	2.60	7.40	3.30	2.70	2.20	5.50
17	.....	9.70	7.20	5.10	2.60	2.10	4.30
18	.....	3.30	9.00	11.00	2.50	2.10	3.40
19	.....	8.90	7.60	5.30	2.40	2.20	3.90
20	.....	4.50	7.40	4.20	2.50	2.30	2.90
21	.....	3.40	11.00	3.90	2.50	2.30	2.60
22	.....	3.30	12.00	3.70	2.50	2.20	2.90
23	.....	3.00	18.00	3.50	2.50	2.20	2.80
24	3.50	2.80	9.20	3.50	2.40	2.50	3.30
25	6.80	2.60	7.50	3.30	2.40	2.30	2.90
26	6.00	2.50	6.00	3.30	2.40	2.30	3.30
27	3.90	2.60	6.20	3.30	2.40	2.20	3.50
28	3.90	2.70	5.90	3.30	2.40	2.10	4.20
29	4.40	3.30	8.20	3.80	2.40	2.20	22.50
30	4.70	2.80	7.30	3.50	2.30	2.20	13.20
31	.....	2.50	6.00	.....	2.40	.....	8.50

CHATTAHOOCHEE RIVER AT OAKDALE, GA.

This station was established October 17, 1895, and is described in Water-Supply Paper No. 48, page 158. The results of measurements during 1900 will be found in the Twenty second Annual Report, Part IV, page 191. During 1901 the following measurements were made by F. A. Murray and others:

List of discharge measurements of Chattahoochee River at Oakdale, Ga.

Date.	Hydrographer.	Gage height.	Discharge.
1901.		*Feet.*	*Second-feet.*
January 12	K. T. Thomas	19.85	21,704
April 11	J. C. Conn	3.55	3,247
June 19	F. A. Murray	4.75	4,446
July 30	do	3.16	2,983
October 24	K. T. Thomas	1.90	1,896

Daily gage height, in feet, of Chattahoochee River at Oakdale, Ga., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.10	4.30	2.40	4.50	3.10	6.80	4.70	2.60	6.00	3.70	1.70	1.60
2	2.30	4.40	2.40	4.50	3.10	6.60	4.10	2.30	5.00	4.60	1.70	1.60
3	2.30	5.00	2.30	4.70	3.10	6.00	3.90	2.10	4.80	4.20	1.60	1.80
4	2.20	5.20	2.30	4.50	3.00	6.00	3.00	1.90	4.60	3.90	1.80	1.80
5	2.20	5.00	2.30	4.30	3.00	5.30	2.90	1.80	4.40	3.60	1.80	1.70
6	2.20	4.70	2.10	4.00	2.90	4.70	2.80	2.20	4.00	3.10	1.80	1.80
7	2.10	4.10	2.10	4.00	2.90	4.30	2.80	9.90	3.70	2.90	1.70	1.80
8	2.10	4.00	2.10	3.70	3.00	4.00	2.70	3.20	3.60	2.80	1.70	1.70
9	2.50	4.20	2.20	3.70	3.00	3.60	2.70	3.00	3.60	2.80	1.70	1.70
10	3.00	4.10	3.30	3.70	3.00	3.40	2.60	2.90	3.60	2.70	1.70	1.70
11	9.00	4.00	6.50	3.70	3.00	3.20	2.60	5.70	3.80	2.70	1.70	1.70
12	19.90	3.60	5.50	6.40	3.00	3.40	2.50	4.00	3.70	2.70	1.60	1.70
13	22.00	3.20	4.40	12.00	3.10	3.80	2.20	4.20	3.60	3.80	1.60	1.60
14	16.00	3.10	3.40	9.50	3.00	5.10	2.10	4.40	3.90	3.20	1.60	1.80
15	8.40	3.00	3.20	7.00	3.00	10.00	2.10	5.60	3.70	2.90	1.60	2.60
16	5.10	2.90	3.20	5.30	2.90	9.80	2.20	9.80	5.70	2.80	1.70	2.00
17	4.40	2.90	3.00	5.00	2.80	8.30	9.10	10.50	3.80	2.80	1.60	1.80
18	4.00	2.80	3.00	6.10	2.80	7.10	5.00	9.30	14.60	2.80	1.60	1.70
19	4.00	2.80	3.00	7.70	2.70	4.20	3.90	9.20	7.20	2.70	1.70	1.70
20	3.80	2.70	3.00	7.00	3.20	3.90	9.00	9.80	4.30	2.70	1.90	1.70
21	3.76	2.70	3.20	5.80	7.10	3.70	4.20	10.80	3.90	2.76	1.80	1.70
22	3.70	2.60	3.20	6.00	18.70	3.50	3.00	17.50	3.90	2.50	1.70	1.70
23	3.40	2.60	3.10	5.40	20.00	3.40	2.90	19.80	3.80	2.30	1.80	1.70
24	3.70	2.50	3.20	5.10	7.80	3.20	2.70	16.40	3.80	2.10	1.80	1.90
25	3.80	2.50	5.30	4.80	6.00	3.20	2.60	10.30	3.60	2.00	1.80	1.80
26	3.50	2.50	10.50	4.80	5.20	4.90	2.40	10.10	3.40	2.00	1.80	1.80
27	3.60	2.40	23.50	4.50	4.00	4.20	2.80	9.80	3.10	1.80	1.70	1.80
28	3.40	2.40	17.00	4.20	3.70	3.90	2.60	9.10	2.90	1.70	1.70	2.40
29	3.10	.....	9.50	3.50	3.10	3.90	2.70	8.70	3.20	1.70	1.70	22.00
30	4.60	.....	7.30	3.10	3.10	3.80	3.10	6.80	3.60	1.70	1.60	27.00
31	4.30	.....	5.00	.....	7.10	.....	3.00	6.60	.....	1.70	.....	25.00

CHATTAHOOCHEE RIVER AT WEST POINT, GA.

This station was established July 30, 1896, on the highway bridge in West Point, Ga., about 500 feet below the railroad bridge. It is described in Water-Supply Paper No. 48, page 159. The observer is C. E. Melton. The results of measurements during 1900 will be found in the Twenty-second Annual Report, Part IV, page 192. During 1901 the following measurements were made by Max Hall and K. T. Thomas:

March 12: Gage height, 4.34 feet; discharge, 6,007 second-feet.
August 6: Gage height, 3 feet; discharge, 3,435 second-feet.
October 28: Gage height, 2.80 feet; discharge, 2,910 second-feet.

Daily gage height, in feet, of Chattahoochee River, at West Point, Ga., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	7.80	4.70	4.70	7.80	4.00	6.70	3.90	3.60	5.80	3.40	2.60	2.50
2	7.20	4.60	4.60	6.70	4.00	6.00	4.50	3.00	5.60	6.30	2.60	2.40
3	7.00	4.60	4.40	6.20	4.00	7.10	5.00	2.90	4.60	5.10	2.60	2.90
4	6.10	12.60	4.20	10.30	4.00	6.90	4.90	2.80	3.90	4.40	2.50	3.20
5	5.30	13.80	4.00	8.60	4.00	5.80	4.20	2.90	3.80	3.60	2.90	3.10
6	4.70	10.20	3.90	6.40	3.90	8.50	3.70	3.00	3.80	3.30	2.80	3.10
7	4.00	6.40	3.70	6.20	3.90	6.40	3.50	4.80	3.60	3.10	2.70	3.00
8	3.90	6.30	3.50	6.00	3.90	5.90	3.30	6.40	3.50	3.00	2.60	3.00
9	3.90	7.00	3.50	5.10	3.90	4.70	3.20	6.00	3.40	2.90	2.60	2.90
10	3.80	6.50	3.40	4.60	3.80	4.20	3.10	4.00	3.30	2.90	2.60	3.50
11	5.00	6.20	4.10	4.00	3.80	4.00	3.00	3.90	3.10	2.90	2.60	3.30
12	13.30	6.00	4.20	3.80	3.80	3.80	3.00	5.30	3.10	2.90	2.50	3.20
13	15.00	5.40	4.50	5.20	3.80	4.00	3.00	4.20	4.70	3.00	2.50	3.00
14	14.70	4.80	4.00	10.40	3.70	4.90	2.90	4.00	4.00	3.10	2.50	3.20
15	12.40	4.50	3.90	8.50	3.90	4.70	2.80	3.80	3.90	3.30	2.50	6.40
16	6.10	4.40	3.70	6.90	3.80	7.90	3.40	6.80	3.40	3.50	2.50	7.10
17	5.00	4.30	3.70	6.00	3.80	7.60	6.60	10.40	5.00	3.20	2.50	7.60
18	6.00	4.20	3.60	5.20	4.00	7.40	3.40	7.60	10.40	3.20	2.40	6.20
19	5.30	4.20	3.40	6.40	4.20	6.20	3.10	10.10	12.70	3.20	2.50	4.40
20	4.80	4.00	3.40	7.60	4.50	4.50	6.40	7.80	7.80	3.10	3.00	3.60
21	4.60	3.90	3.60	7.00	8.40	4.20	4.20	6.50	4.80	3.00	3.40	3.30
22	4.40	3.90	3.80	6.20	15.70	4.00	3.90	8.20	4.10	2.80	3.50	3.30
23	4.30	3.80	4.00	5.50	17.20	3.90	3.70	14.10	3.89	2.80	3.10	3.20
24	4.20	3.80	4.30	5.00	12.80	3.80	3.20	17.10	3.60	2.80	2.90	3.10
25	4.10	4.60	4.00	4.80	10.50	3.70	3.00	13.60	3.40	2.80	2.80	3.90
26	4.00	4.20	3.90	4.60	6.20	3.70	2.90	8.20	3.40	2.70	2.70	4.60
27	3.90	4.00	9.60	4.40	5.50	4.70	2.80	7.10	3.30	2.70	2.60	5.40
28	4.00	3.90	12.10	4.20	5.00	4.20	2.80	6.00	3.30	2.70	2.60	6.80
29	4.90	.....	13.00	4.10	4.30	4.00	3.90	5.80	3.80	2.76	2.50	19.00
30	4.80	.....	5.90	4.10	5.60	3.80	4.10	5.30	3.50	2.70	2.50	25.00
31	4.70	.....	7.80	.....	7.00	....	4.00	5.50	..	2.70	....	20.00

HILLABEE CREEK NEAR ALEXANDER CITY, ALA.

This station, which was established August 29, 1900, by J. R. Hall, is located 6½ miles northeast of Alexander City, on the road leading from that town to Newsite. It is described in Water-Supply Paper No. 48, page 172. During 1901 the following measurements were made by James R. Hall:

January 22: Gage height, 2.5 feet; discharge, 606 second-feet.
September 12: Gage height, 1 foot; discharge, 139 second-feet.

Daily gage height, in feet, of Hillabee Creek near Alexander City, Ala., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	5.00	2.40	2.30	5.20	2.50	2.50	2.50	1.80	2.60	1.20	1.00	1.00
2	4.90	2.40	2.30	4.40	2.50	2.40	2.50	1.40	2.00	1.20	1.00	1.00
3	4.90	4.60	2.40	4.80	2.50	3.00	2.40	1.40	1.40	1.10	1.00	2.00
4	4.70	9.40	2.40	3.10	2.40	2.50	2.30	1.20	1.20	1.10	1.00	1.60
5	3.90	6.00	2.30	2.90	2.40	2.50	2.00	1.10	1.10	1.10	1.30	1.40
6	3.60	4.10	2.20	2.80	2.40	2.60	1.80	1.10	1.10	1.20	1.10	1.20
7	3.60	3.60	2.10	2.70	2.40	2.50	2.90	1.10	1.10	1.40	1.10	1.20
8	3.40	3.10	2.10	2.60	2.40	2.50	2.10	1.00	1.10	1.20	1.00	1.20
9	2.60	3.60	2.10	2.60	2.30	2.40	1.80	1.20	1.10	1.20	1.00	1.20
10	2.50	3.00	2.40	2.50	2.30	2.40	1.80	1.20	1.10	1.20	1.00	1.90
11	8.00	2.90	2.50	2.50	2.30	2.30	1.70	1.10	1.00	1.60	1.00	1.50
12	7.60	2.90	2.30	2.40	2.20	2.00	1.60	1.10	1.00	2.00	1.00	1.40
13	7.00	2.80	2.20	3.10	2.50	2.10	1.50	1.20	1.20	2.90	1.00	1.40
14	5.90	3.00	2.20	2.90	2.30	2.00	1.40	1.60	2.50	1.60	1.00	2.00
15	4.50	3.10	2.30	2.80	2.50	2.00	1.30	2.10	2.40	1.40	1.00	3.00
16	4.30	2.60	2.40	2.70	2.20	1.90	1.40	4.40	2.40	1.20	1.00	3.00
17	4.00	2.60	2.20	2.60	2.20	2.20	1.30	2.90	2.00	1.00	1.00	2.80
18	3.50	2.40	2.20	2.60	2.10	1.90	3.40	2.00	1.80	1.00	1.00	2.70
19	3.40	2.60	2.10	10.00	2.10	1.80	2.20	2.00	1.60	1.00	1.30	2.60
20	3.00	2.70	2.10	3.20	2.90	1.80	1.80	4.00	1.40	1.00	1.30	2.00
21	2.90	2.60	3.00	3.10	3.80	1.70	2.00	4.10	1.20	1.00	1.30	1.50
22	2.90	2.40	2.40	3.00	2.90	1.70	1.90	3.40	1.40	1.00	1.30	1.50
23	2.80	2.60	2.30	2.90	2.50	1.60	1.80	3.10	1.20	1.00	1.30	1.50
24	2.60	2.60	2.80	2.80	2.50	1.60	1.80	2.90	1.10	1.00	1.30	1.60
25	2.50	2.50	2.70	2.70	2.40	1.70	1.70	2.20	1.10	1.00	1.20	1.60
26	2.60	2.40	3.50	2.60	3.90	1.70	1.70	2.20	1.20	1.00	1.20	1.70
27	2.60	2.40	3.00	2.50	2.80	1.80	1.40	2.10	2.10	1.00	1.10	1.70
28	2.50	2.40	2.70	2.50	2.60	1.80	1.60	3.80	1.60	1.00	1.10	1.80
29	2.40	.....	2.60	2.50	2.50	1.70	1.40	3.60	1.40	1.00	1.10	11.00
30	2.40	.....	2.70	2.50	2.30	2.60	1.40	3.40	1.20	1.00	1.10	4.90
31	2.40	.....	5.20	.....	2.90	.....	2.00	3.00	.....	1.00	.....	3.90

TALLAPOOSA RIVER NEAR STURDEVANT, ALA.

This station was established July 19, 1900, by J. R. Hall. It is located at the Columbus and Western Railroad bridge a fourth of a mile west of Sturdevant, and is described in Water-Supply Paper No. 48, page 167.

A measurement was made March 8, 1901, by James R. Hall, at a gage height of 3.40 feet, giving a discharge of 3,774 second-feet.

Daily gage height, in feet, of Tallapoosa River, near Sturdevant, Ala., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	7.00	4.60	3.80	7.40	3.80	5.50	4.00	3.10	3.20	2.40	1.60	1.70
2	6.80	4.50	3.80	6.80	3.70	5.50	3.50	2.80	2.90	4.50	1.60	1.70
3	6.00	5.80	3.70	8.30	3.70	5.30	3.20	2.50	2.70	6.00	1.60	2.10
4	5.40	12.90	3.70	7.40	3.60	5.20	3.00	2.30	2.60	3.40	1.60	2.20
5	4.90	9.40	3.60	5.70	3.50	4.80	2.90	2.30	2.40	2.70	1.70	2.30
6	5.20	7.70	3.60	5.00	3.50	4.60	2.80	2.20	2.30	2.30	1.80	2.20
7	5.10	6.50	3.50	4.70	3.40	5.60	4.30	2.10	2.20	2.10	1.80	2.10
8	4.00	5.40	3.40	4.40	3.40	4.90	4.00	2.40	2.10	2.00	1.80	2.10
9	4.00	5.70	3.40	4.20	3.30	3.80	3.40	2.20	2.00	2.00	1.80	2.20
10	4.10	5.40	3.90	4.00	3.30	3.60	3.00	2.00	2.00	2.00	1.80	2.20
11	6.00	5.20	4.30	3.90	3.30	3.40	2.00	2.20	2.00	1.90	1.70	2.30
12	14.10	5.10	4.00	3.90	3.20	3.30	2.30	2.40	2.00	1.90	1.70	2.20
13	11.00	4.80	3.80	4.10	3.20	3.20	2.20	2.30	2.00	2.10	1.70	2.10
14	9.20	4.60	3.60	6.00	3.40	4.90	2.10	2.20	4.00	2.10	1.80	3.00
15	6.10	4.40	3.40	6.40	3.30	4.40	2.10	2.00	3.40	2.00	1.80	7.80
16	5.30	4.30	3.30	5.30	3.20	4.10	2.00	5.30	2.80	2.00	1.80	5.90
17	5.70	4.20	3.30	4.70	3.10	3.80	2.20	7.20	3.60	1.90	1.80	4.10
18	5.30	4.20	3.20	4.40	3.00	3.60	3.80	5.90	7.00	1.90	1.80	3.50
19	4.00	4.10	3.20	8.50	3.00	3.30	3.60	5.30	5.20	1.80	2.00	3.00
20	4.40	4.10	3.60	9.00	3.30	3.10	3.20	6.60	4.30	1.80	2.20	2.80
21	4.30	4.00	4.30	6.70	6.10	3.00	3.00	5.80	3.40	1.70	2.20	2.60
22	4.20	4.00	3.90	5.20	7.60	2.90	2.80	5.60	3.00	1.70	2.30	2.50
23	4.10	4.00	3.70	4.80	7.00	2.80	2.40	11.70	2.40	1.70	2.20	2.50
24	4.20	4.00	4.50	4.60	6.50	2.70	2.20	8.30	2.30	1.70	2.20	3.00
25	4.30	4.00	4.30	4.40	5.30	2.70	2.10	5.20	2.20	1.70	2.10	2.80
26	4.20	4.00	5.40	4.30	6.80	2.60	2.10	4.00	2.10	1.70	2.10	2.70
27	4.10	3.90	8.70	4.20	4.50	2.60	2.10	3.30	2.00	1.60	2.00	2.60
28	4.30	3.90	8.20	4.10	4.40	2.50	2.10	4.40	2.00	1.60	1.90	2.80
29	4.50	.....	7.50	4.00	4.30	2.50	2.00	5.20	2.20	1.60	1.80	15.70
30	4.50	.....	5.00	3.90	4.20	5.20	2.10	4.30	2.30	1.60	1.80	17.20
31	4.60	.....	8.90	.....	4.00	.....	2.80	3.50	.....	1.60	.....	12.00

BIG SANDY CREEK NEAR DADEVILLE, ALA.

The station was established by J. R. Hall, August 2, 1900. It is located about 4½ miles southwest of Dadeville, at the highway bridge on the Dadeville-Susanna road. On December 29, 1901, the bridge and gage were washed out by the great flood of that date, and the gage was not replaced, the station being discontinued.

The station is described in Water-Supply Paper No. 48, page 174. Results of measurements will be found in the Twenty-second Annual Report, Part IV, page 209. During 1901 the following discharge measurements were made by J. R. Hall:

February 26: Gage height, 1.45 feet; discharge, 367 second-feet.
March 30: Gage height, 11.10 feet; discharge, 5,327 second-feet.
March 31: Gage height, 13.00 feet; discharge, 6,320 second-feet.

Daily gage height, in feet, of Big Sandy Creek near Dadeville, Ala., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.90	1.35	1.40	4.40	1.40	1.40	1.30	1.10	1.30	4.20	0.85	0.90
2	1.90	1.35	1.40	7.40	1.40	1.40	1.25	1.10	1.30	4.00	.85	.90
3	1.95	3.10	2.35	2.70	1.45	4.00	1.20	1.00	1.20	3.00	.85	1.40
4	1.70	6.00	1.35	2.00	1.35	5.60	1.20	1.05	1.10	3.50	.85	1.40
5	1.60	1.90	1.35	1.80	1.35	1.90	1.40	1.10	1.10	2.00	.85	1.40
6	1.50	1.75	1.40	1.60	1.35	3.50	1.50	1.05	1.10	1.80	.90	1.30
7	1.45	1.55	1.35	1.50	1.40	2.40	1.40	1.30	1.00	1.80	.90	1.10
8	1.40	2.10	1.35	1.50	1.35	1.90	1.25	1.20	1.00	1.50	1.00	1.00
9	1.40	3.50	1.40	1.50	1.35	1.50	1.20	1.10	1.00	1.40	1.00	1.10
10	1.40	2.20	1.45	1.50	1.30	1.60	1.20	1.10	.90	1.20	1.00	1.00
11	1.90	2.00	1.40	1.50	1.30	1.70	1.10	1.10	.90	1.20	1.00	1.00
12	1.70	1.70	1.35	1.55	1.35	2.00	1.10	1.20	.85	1.00	.90	1.00
13	2.50	1.50	1.35	1.65	1.35	1.80	1.10	1.15	.80	1.90	1.00	1.10
14	1.90	1.50	1.35	1.65	1.50	1.90	1.10	1.10	1.40	1.90	1.00	4.40
15	1.60	1.50	1.30	1.60	1.50	1.15	1.80	1.00	1.40	1.80	1.00	3.80
16	1.55	1.45	1.30	1.50	1.45	1.70	1.50	5.00	1.80	1.80	1.00	3.00
17	2.00	1.45	1.30	1.50	1.25	1.50	1.50	1.80	2.00	1.70	1.00	2.90
18	2.00	1.45	1.35	1.45	1.40	1.50	1.50	1.80	1.80	1.70	.90	2.50
19	1.60	1.50	1.35	6.00	1.40	1.45	1.30	1.40	1.80	1.70	.90	2.40
20	1.50	1.50	1.80	2.50	1.70	1.45	1.20	1.30	1.70	1.70	.80	2.40
21	1.50	1.45	1.60	2.40	7.00	1.40	1.15	1.20	1.40	1.60	.80	2.00
22	1.45	1.40	1.40	2.10	3.40	1.35	1.15	1.50	1.30	1.60	1.00	2.00
23	1.45	1.40	1.40	1.80	1.80	1.40	1.15	1.50	1.30	1.00	1.00	1.90
24	1.45	1.50	2.20	1.80	1.70	1.40	1.10	1.50	1.20	1.00	.85	1.80
25	1.50	1.50	2.10	1.70	1.50	1.35	1.10	1.40	1.20	.90	.85	1.50
26	1.50	1.45	1.70	1.60	2.70	1.30	1.10	1.40	1.10	.90	.80	3.00
27	1.45	1.45	1.70	1.45	1.80	1.30	1.15	1.20	1.00	.70	.90	3.00
28	1.40	1.45	1.40	1.45	1.50	1.20	1.20	2.00	1.00	.60	.90	21.00
29	1.40		1.40	1.45	1.50	1.15	1.15	1.50	1.80	.70	.90	16.00
30	1.40		2.30	1.45	1.45	1.20	1.10	1.40	1.80	.70	.90	8.00
31	1.40		13.10		1.40		1.10	1.40		.80		4.00

TALLAPOOSA RIVER NEAR SUSANNA, ALA.

This station was established July 27, 1900, by J. R. Hall. It is located at the mouth of Blue Creek, which is 10 feet above the east landing of McCartys Ferry, 13 miles southwest of Dadeville and 3 miles from Susanna, the nearest post-office.

On March 31, 1901, the gage was washed out and it was decided not to replace it, so the station was discontinued at that time.

The station is described in Water-Supply Paper, No. 48, page 166.

Results of measurement will be found in the Twenty-second Annual Report, part IV, page 205.

During 1901 the following measurements were made by J. R. Hall:

January 9: Gage height, 2.80 feet; discharge, 5,628 second-feet.
February 27: Gage height, 2.90 feet; discharge, 5,135 second-feet.

Daily gage height, in feet, of Tallapoosa River, near Susanna, Ala., for 1901.

Day.	Jan.	Feb.	Mar.	Day.	Jan.	Feb.	Mar.
1	6.00	3.40	2.70	17	5.00	3.10	2.40
2	6.00	3.45	2.60	18	4.50	3.10	2.40
3	5.10	3.65	2.65	19	3.90	3.05	2.45
4	4.50	11.50	2.70	20	3.40	3.00	3.00
5	3.90	9.50	2.65	21	3.20	2.90	3.40
6	3.50	6.50	2.60	22	3.10	2.85	2.90
7	3.20	4.40	2.50	23	3.00	2.80	2.70
8	3.00	4.30	2.40	24	3.10	2.90	3.30
9	2.90	4.80	2.50	25	3.40	3.00	3.40
10	2.80	4.90	2.70	26	3.10	3.00	3.60
11	3.40	4.50	3.30	27	3.20	2.90	7.40
12	13.50	4.00	3.00	28	3.10	2.80	6.90
13	11.50	3.50	2.90	29	3.00	.....	6.10
14	8.00	3.40	2.60	30	3.20	.....	4.10
15	6.10	3.30	2.50	31	3.30	.....	4.10
16	4.50	3.20	2.40				

TALLAPOOSA RIVER NEAR MILSTEAD, ALA.

This station was established August 7, 1897, at the bridge of the Tallassee and Montgomery Railway, about a fourth of a mile from Milstead. It is described in Water-Supply Paper, No. 48, page 168. The gage was last verified October 29, 1901. The flood of December, 1901, was one of unusual magnitude. The flow at Milstead, as computed from the head with which the river discharged over milldams in that locality, is estimated at 70,000 second-feet, an amount considerably in excess of that given by the rating table. The difference is ascribed to unusual conditions prevailing at that time. Coosa River, which joins the Tallapoosa about 20 miles below Milstead, had not reached the flood stage, and there was therefore complete absence of the backwater effects which usually obtain on Tallapoosa River when there is high water on both rivers, upon which latter condition the rating table is based. The crest of the flood on Coosa River did not reach the confluence until twenty-four hours later. Records of discharge measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 206. During 1901 the following measurements were made by Max Hall and others:

February 12: Gage height, 10.70 feet; discharge, 11,759 second-feet.
March 13: Gage height, 5.55 feet; discharge, 5,644 second-feet.
October 29: Gage height, 1.70 feet; discharge, 1,583 second-feet.

Daily gage height, in feet, of Tallapoosa River near Milstead, Ala., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	14.30	7.40	5.30	26.00	5.00	8.70	5.10	2.10	4.00	2.20	1.70	2.00
2	15.50	7.20	5.20	22.00	4.80	8.60	4.20	2.20	3.50	2.90	1.70	2.00
3	14.50	7.50	5.10	23.00	4.70	9.70	4.30	2.30	2.90	6.10	1.70	1.95
4	11.00	24.07	5.00	18.00	4.60	10.90	4.00	2.20	2.70	6.40	1.80	2.20
5	9.80	26.00	4.90	14.20	4.40	8.00	3.30	2.10	2.40	5.10	1.95	2.40
6	8.70	18.30	4.70	10.80	4.30	7.30	3.60	2.10	2.20	4.00	1.95	2.40
7	7.40	12.60	4.50	9.60	4.20	12.10	4.00	2.60	2.10	3.20	2.00	2.30
8	6.10	10.50	4.40	7.20	4.20	10.10	4.80	2.60	2.00	2.50	1.90	2.20
9	5.30	13.10	4.40	6.80	4.10	6.30	4.70	2.30	2.00	2.10	1.90	2.20
10	5.00	14.00	4.70	6.20	3.90	5.90	3.70	2.30	1.90	2.00	2.00	2.20
11	6.00	12.60	7.80	5.80	3.80	4.50	2.90	2.10	1.90	1.90	1.90	2.30
12	24.20	10.90	6.00	5.60	3.80	4.10	2.60	2.30	1.80	1.90	1.80	2.50
13	30.50	9.80	5.50	6.10	3.80	4.20	2.60	2.90	1.80	1.90	1.80	2.40
14	22.00	8.20	6.00	8.80	4.50	5.30	2.10	2.50	2.80	2.00	1.75	2.60
15	18.00	7.70	5.50	10.70	4.30	7.30	2.20	2.10	4.20	2.10	1.75	6.00
16	11.50	6.90	5.10	8.70	4.00	5.70	2.30	3.20	3.10	2.10	1.80	13.40
17	12.20	6.60	4.50	7.70	3.60	6.00	5.30	8.90	3.00	2.00	1.80	9.00
18	12.10	6.50	4.10	11.00	3.50	5.20	4.80	8.00	5.60	1.90	1.80	6.00
19	9.70	6.30	4.00	23.00	3.50	4.40	4.30	6.60	9.10	1.90	1.90	3.90
20	8.00	5.20	6.00	22.00	5.50	4.00	3.50	5.90	7.10	1.80	2.10	3.60
21	7.10	5.90	7.90	13.40	10.50	3.60	3.30	9.60	5.00	1.80	2.20	3.40
22	6.80	5.80	6.30	10.70	16.20	3.30	3.10	7.20	3.80	1.70	2.20	3.20
23	6.40	5.60	6.20	8.90	14.20	3.30	2.80	20.75	2.70	1.70	2.30	3.10
24	6.20	6.00	10.10	7.60	12.00	3.20	3.50	21.00	2.30	1.70	2.20	3.10
25	7.00	6.10	8.90	6.90	9.00	3.10	2.40	9.40	2.10	1.70	2.20	3.00
26	6.80	6.10	10.20	6.50	10.00	3.00	2.20	5.90	2.80	1.70	2.10	2.90
27	6.70	6.00	14.30	6.10	8.40	2.90	2.50	4.20	2.00	1.70	2.30	2.95
28	6.70	5.50	17.50	5.70	6.40	2.80	2.50	5.90	2.10	1.70	2.20	3.05
29	6.60	.....	15.00	5.50	6.00	2.60	2.30	8.70	2.30	1.70	2.10	38.00
30	6.80	.....	9.90	5.20	5.10	2.60	2.20	7.70	2.50	1.70	2.00	47.00
31	7.00	.....	31.50	.....	4.80	.....	2.20	4.70	.....	1.70	.....	39.00

ETOWAH RIVER AT CANTON, GA.

This station was established by the United States Weather Bureau March 12, 1892. It is located on the iron highway bridge about 1,000 feet north of the Atlanta, Knoxville and Northern Railway station at Canton, and about a half mile north of Canton Creek. The gage is a vertical timber attached to the upstream side of the left-bank pier of the bridge. During 1901 it was provided with brass figures correcting the 1-foot error made in placing it the year before. This station is described in Water-Supply Paper No. 48, page 160. Results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 193. During 1901 the following measurements were made by Max Hall and others.

February 5: Gage height, 2.85 feet; discharge, 2,578 second-feet.
April 25: Gage height, 1.50 feet; discharge, 1,684 second-feet.
August 16: Gage height, 2.85 feet; discharge, 2,781 second-feet.
November 2: Gage height, 0.25 foot; discharge, 686 second-feet.

Daily gage height, in feet, of Etowah River, at Canton, Ga., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.10	1.20	0.80	1.80	1.00	4.60	1.70	0.60	2.40	0.70	0.50	0.60
2	1.80	1.00	.80	3.60	.90	2.40	1.20	.60	2.30	.80	.50	.80
3	1.30	1.30	.70	4.80	.90	2.00	1.00	.50	2.20	2.90	.50	.80
4	.90	6.00	.70	3.40	.80	3.60	.80	.50	2.00	2.80	.50	.90
5	.70	4.10	.70	2.50	.80	3.00	.70	.50	1.80	2.00	.60	.90
6	.70	2.00	.60	2.30	.80	2.80	.70	.40	1.70	1.00	.60	.90
7	.70	2.00	.60	2.00	.90	3.40	2.60	1.10	1.50	.90	.60	.90
8	.60	1.80	.60	1.90	.90	1.30	1.80	.70	1.30	.80	.60	.90
9	.60	4.00	.60	1.30	.90	1.20	1.00	.60	1.10	.60	.60	.90
10	.60	3.10	.80	1.00	.90	1.20	.90	.50	1.00	.60	.60	1.20
11	6.40	3.00	.90	.90	.90	1.00	.80	.80	.90	.60	.70	1.10
12	14.00	2.60	.80	.80	.90	.80	.70	1.90	.90	.60	.70	1.10
13	4.50	2.30	.90	1.70	.80	1.40	.70	1.40	.80	.60	.70	1.10
14	2.10	2.10	.90	3.00	.80	2.35	.60	1.20	.80	.50	.70	1.20
15	1.80	1.80	.90	2.50	.90	5.30	.60	1.50	.70	.50	.70	4.00
16	1.40	1.80	.80	2.00	.90	4.65	.60	2.50	.70	.50	.60	3.40
17	1.10	1.80	.80	1.70	1.70	3.20	.80	3.20	1.50	.50	.60	3.00
18	1.00	1.80	.70	1.30	.80	3.10	1.70	2.80	2.80	.40	.60	2.00
19	1.00	1.80	.70	4.06	.80	2.80	1.90	5.00	1.40	.40	.70	1.70
20	1.00	1.60	.70	4.20	2.70	1.70	1.60	3.20	1.00	.40	.70	1.50
21	.80	1.50	.60	3.80	12.20	1.50	1.10	5.20	.90	.30	.70	1.20
22	.80	1.30	.60	2.60	16.60	1.30	1.00	7.00	.80	.30	.70	1.20
23	.70	1.20	.60	2.40	5.70	1.20	.80	13.00	.70	.30	.80	1.20
24	.90	1.00	.80	1.80	3.10	1.10	.70	3.20	.70	.20	1.00	1.10
25	.90	.90	.80	1.60	2.80	1.00	.60	2.50	.60	.20	1.00	1.20
26	.90	.90	17.00	1.50	2.40	.90	.50	2.30	.60	.20	.90	1.20
27	1.00	.80	6.80	1.40	2.00	3.60	.90	2.10	.60	.20	.80	2.40
28	1.30	.80	3.40	1.30	1.80	3.90	.80	3.90	.70	.20	.70	3.60
29	1.20	.....	3.00	1.20	1.60	2.30	.70	2.70	.80	.20	.70	20.00
30	1.00	.....	2.00	1.10	1.40	2.10	.70	2.50	.70	.10	.70	17.00
31	1.30	.....	1.80	.....	2.40	.....	.70	2.40	.....	.10	.....	4.00

COOSAWATTEE RIVER AT CARTERS, GA.

This station was established August 15, 1896, at the iron highway bridge at Carters, Murray County, Ga., about 20 miles northeast of Calhoun. The station is described in Water-Supply Paper No. 48, page 161. Records of measurements during 1900 will be found in the Twenty-second Annual Report, Part IV, page 197. During 1901 the following measurements were made by O. P. Hall:

April 20: Gage height, 7 feet; discharge, 3,917 second-feet.
June 21: Gage height, 2.92 feet; discharge, 1,283 second-feet.
October 25: Gage height, 1.95 feet; discharge, 717 second-feet.

Daily gage height, in feet, of Coosawattee River at Carters, Ga., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.10	4.00	2.30	5.00	3.00	5.00	3.30	1.70	3.70	2.60	1.80	2.00
2	3.00	3.00	2.20	8.00	2.90	3.80	3.20	2.00	3.50	2.60	1.70	2.30
3	2.50	6.75	2.20	6.00	2.90	3.50	3.00	2.10	3.00	2.50	1.70	2.50
4	2.50	6.00	2.30	5.00	2.80	3.40	2.80	2.50	3.00	2.50	1.70	2.50
5	2.40	8.50	2.20	4.50	2.80	3.30	2.80	5.00	2.70	2.40	1.80	2.60
6	2.20	5.00	2.30	4.50	2.60	3.10	2.60	4.50	2.60	2.40	1.80	2.80
7	2.10	4.00	2.30	4.20	2.60	3.00	3.00	3.00	2.50	2.30	1.70	2.90
8	2.10	4.00	2.20	4.00	2.50	3.20	2.80	2.50	2.50	2.20	1.80	3.00
9	2.05	6.50	2.10	3.90	2.50	3.20	2.60	2.00	2.40	2.20	1.90	3.10
10	2.00	5.20	4.80	3.90	2.40	3.40	2.60	2.25	2.40	1.10	1.80	3.00
11	16.50	5.00	3.60	3.80	2.40	3.50	2.50	2.00	2.60	2.10	1.80	2.90
12	6.00	4.50	3.20	3.50	2.30	4.00	2.40	2.50	2.70	2.00	1.70	2.90
13	6.00	4.00	3.00	3.50	2.40	4.50	2.50	3.00	2.50	2.00	1.70	3.00
14	5.00	3.50	2.80	3.20	2.50	5.00	2.40	9.00	2.50	2.00	1.80	21.00
15	4.10	3.20	2.70	4.60	2.40	5.20	2.30	4.50	3.00	1.90	1.80	9.00
16	3.60	3.00	2.60	4.20	2.50	4.80	2.20	5.00	19.00	1.90	1.90	6.00
17	3.20	3.00	2.50	4.00	2.50	4.00	2.00	4.50	7.00	1.80	1.80	4.50
18	3.00	3.00	2.60	4.00	3.00	3.50	1.80	5.00	4.50	1.80	1.90	3.00
19	3.00	2.90	2.70	12.00	3.00	3.00	1.60	5.00	4.00	1.80	1.90	2.90
20	2.50	2.90	2.60	7.00	4.00	2.80	1.80	6.00	3.50	1.90	1.80	2.90
21	2.50	2.80	2.50	6.00	19.50	2.60	2.00	17.00	4.50	1.90	1.80	2.80
22	2.70	2.80	2.50	5.00	12.00	2.60	2.20	15.00	3.40	1.80	1.90	2.80
23	2.80	2.60	2.70	4.10	8.00	2.50	2.30	10.00	3.20	1.80	1.90	3.00
24	3.00	2.60	3.20	3.80	6.00	2.50	2.00	8.00	3.10	1.70	2.00	2.90
25	3.00	2.50	14.65	3.70	5.00	2.40	2.00	7.00	3.00	1.70	2.00	3.00
26	2.60	2.40	18.30	3.50	5.00	2.40	2.00	6.50	3.00	1.80	2.10	3.10
27	2.60	2.50	9.00	3.40	4.50	2.60	1.90	6.00	2.90	1.80	2.00	5.50
28	2.40	2.40	7.00	3.20	4.50	2.60	1.80	4.00	2.80	1.80	1.90	9.00
29	2.40	.....	7.00	3.00	4.40	3.00	1.70	4.00	2.60	1.80	1.80	23.00
30	2.50	.....	6.00	3.00	4.20	3.50	1.60	4.20	2.70	1.90	1.80	13.00
31	3.50	.....	6.20	.....	4.00	.....	1.50	4.00	.....	1.90	.....	11.00

OOSTANAULA RIVER AT RESACA, GA.

This station was established July 27, 1896, on the iron bridge of the Western and Atlantic Railroad in the town of Resaca, Ga., 1,000 feet from the railroad station. It is described in Water-Supply Paper No. 48, page 162. Records of measurements for 1899 will be found in the Twenty-first Annual Report, Part IV, page 147, and for 1900 in the Twenty-second Annual Report, Part IV, page 198. No measurements were made at this station during the year 1901, nor were gage-height records maintained, except by the United States Weather Bureau, for the half year January 1 to April 30 and November 1 to December 31.

Daily gage height, in feet, of Oostanaula River at Resaca, Ga., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	9.40	8.40	4.00	8.30		[a]8.70						2.90
2	7.60	6.90	4.00	9.30								2.80
3	6.00	6.40	4.00	14.20								3.20
4	5.60	15.70	4.00	13.20								4.20
5	5.00	16.10	4.00	11.70								4.00
6	4.60	12.70	4.40	8.30				[a]3.70				3.50
7	4.00	8.40	4.50	7.60		[a]8.60		[a]10.20				3.60
8	4.00	7.20	4.20	6.80								3.40
9	4.00	12.20	4.40	6.40								3.40
10	4.00	13.40	9.20	6.20								4.00
11	11.60	9.00	12.00	5.70				[a]3.80				4.50
12	21.80	8.00	10.90	5.60								4.30
13	25.70	7.20	8.40	5.60						[a]3.60	3.30	3.90
14	26.70	6.60	6.20	11.60				[a]4.80			3.00	4.00
15	24.08	6.40	5.60	10.60				[a]7.80			3.10	19.70
16	18.80	5.90	5.20	7.90		[a]8.30		[a]11.70			3.00	22.40
17	8.90	5.80	5.00	6.80				[a]13.40	[a]7.60		2.90	22.80
18	6.80	5.60	4.80	6.40			[a]3.60		[a]6.40		2.80	20.00
19	6.00	5.40	4.70	12.80				[a]13.40			2.90	9.60
20	5.80	5.40	4.70	19.80	[a]11.00			[a]15.10			3.30	5.30
21	5.40	5.20	5.20	20.80	[a]13.80						3.40	4.80
22	5.40	5.00	5.00	20.70	[a]21.60			[a]12.40			3.30	4.10
23	5.20	4.80	4.80	18.00	[a]25.21			[a]18.50			3.00	4.30
24	6.00	4.80	5.20	9.60				[a]20.10			3.90	6.10
25	9.10	4.60	5.80	7.70				[a]15.50			3.70	6.00
26	7.80	4.50	21.20	6.90							3.50	5.40
27	6.40	4.40	25.40	6.60							3.20	8.90
28	6.80	4.30	25.80	6.20				[a]7.60			3.10	10.20
29	6.40		23.20	6.00							3.00	19.30
30	6.70		17.20	5.80		[a]5.00					2.90	23.80
31	9.70		9.60		[a]5.90							26.60

[a] Special readings.

COOSA RIVER AT ROME, GA.

This station is described in Water-Supply Paper No. 36, page 148. Measurements of flow are made at Rome, also at Riverside, 120 miles farther downstream. The measurements at Rome are made on the Oostanaula and the Etowah just above their junction to form the Coosa. Etowah River is measured at the Second avenue bridge, and Oostanaula River at the Fifth avenue bridge, and the results added together give the flow of Coosa River at Rome. Results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 199. During 1901 the following measurements were made by F. A. Murray and others:

January 23: Gage height, 3.60 feet; discharge, 6,454 second-feet.
April 5: Gage height, 9.90 feet; discharge, 16,692 second-feet.
June 22: Gage height, 3.70 feet; discharge, 6,030 second-feet.
October 15: Gage height, 3.15 feet; discharge, 5,388 second-feet.

Daily gage height, in feet, of Coosa River at Rome, Ga., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	7.40	6.40	3.00	8.80	4.00	10.60	3.60	1.80	6.40	2.60	1.20	1.30
2	6.40	5.80	3.00	8.60	3.80	7.60	3.00	1.80	5.80	2.60	1.20	1.30
3	5.20	5.50	3.00	13.00	3.80	5.60	3.00	1.80	3.70	3.20	1.20	1.30
4	4.20	15.80	3.00	13.00	3.80	6.40	2.60	1.60	3.40	3.00	1.20	1.50
5	4.00	18.50	3.00	10.00	3.60	5.00	2.40	1.60	3.00	2.80	1.20	2.00
6	3.80	13.80	3.00	7.90	3.50	4.00	2.20	2.60	2.90	2.20	1.20	1.80
7	3.50	9.50	3.00	6.40	3.50	7.00	5.20	5.30	2.60	2.00	1.20	1.80
8	3.20	6.50	3.00	5.60	3.40	7.60	4.80	5.90	2.20	1.90	1.10	1.80
9	3.00	9.60	2.80	5.20	3.30	5.40	3.30	3.00	2.00	1.90	1.10	1.80
10	2.80	12.50	5.50	4.50	3.10	4.30	2.60	2.60	2.00	1.80	1.10	1.80
11	8.80	10.50	7.80	4.30	3.00	4.00	2.40	2.50	2.00	1.70	1.00	2.60
12	23.50	7.60	8.00	4.20	2.90	3.80	2.30	3.40	2.00	1.60	1.00	2.60
13	27.00	6.50	6.70	4.30	2.80	3.80	2.00	3.00	1.80	1.80	1.00	2.10
14	23.80	5.60	4.80	10.40	2.80	4.00	2.00	2.30	2.00	2.00	1.00	2.20
15	21.40	5.00	4.00	10.10	2.70	4.30	2.00	4.50	3.00	3.20	1.00	16.40
16	19.80	4.80	3.66	7.70	2.60	6.90	1.90	7.20	2.40	2.60	1.00	17.60
17	17.40	4.20	3.20	5.80	2.60	6.00	1.70	10.50	6.00	2.40	1.00	14.70
18	8.90	4.20	3.90	5.20	2.50	5.00	5.50	9.80	11.20	2.40	1.00	14.00
19	5.00	4.20	3.00	9.00	2.50	4.80	3.00	10.80	11.10	2.00	1.00	13.00
20	4.00	4.00	3.00	18.60	3.00	4.00	3.00	12.50	7.00	1.80	1.00	5.60
21	3.80	3.80	3.00	17.20	10.00	3.80	2.40	10.80	3.90	1.80	1.60	3.00
22	3.80	3.70	3.00	15.50	23.60	3.60	2.40	14.50	3.70	1.60	1.20	2.00
23	3.80	3.60	3.00	14.60	26.40	3.60	2.40	20.80	3.30	1.60	1.40	2.00
24	3.80	3.60	3.60	12.70	21.80	3.60	2.00	23.20	2.80	1.60	1.40	3.60
25	6.70	3.50	3.60	6.80	18.90	2.70	2.00	18.30	2.60	1.60	1.30	4.00
26	6.60	3.20	22.00	5.60	16.50	2.70	1.90	13.10	2.50	1.40	1.30	3.70
27	5.40	3.20	27.00	4.80	11.10	3.20	1.70	6.60	2.30	2.30	1.30	5.70
28	5.20	3.00	24.50	4.40	5.50	3.00	2.80	8.80	2.00	1.30	1.30	6.00
29	5.00	.....	21.30	4.20	4.90	3.60	1.90	7.50	2.00	1.30	1.30	21.50
30	4.60	.....	19.20	4.10	4.70	3.60	1.90	6.20	2.50	1.30	1.80	29.80
31	6.80	.....	16.10	.....	5.40	.....	1.60	5.60	.....	1.20	.....	32.60

COOSA RIVER NEAR RIVERSIDE, ALA.

This station, established September 25, 1896, is at the bridge of the Southern Railway near Riverside. It is described in Water-Supply Paper No. 48, page 164. Records of measurements during 1900 will be found in the Twenty-second Annual Report, Park IV, page 200. During 1901 the following measurements were made by Max Hall and others:

January 8: Gage height, 3.85 feet; discharge, 9,572 second-feet.
March 18: Gage height, 3.70 feet; discharge, 9,333 second-feet.
August 24: Gage height, 12.95 feet; discharge, 44,551 second-feet.
November 14: Gage height, 1.70 feet; discharge, 4,039 second-feet.

Daily gage height, in feet, of Coosa River near Riverside, Ala., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	7.30	6.00	3.55	14.35	4.80	5.20	3.00	2.15	5.60	2.70	1.90	1.85
2	7.35	6.50	3.50	14.40	4.60	8.20	2.90	2.10	5.00	4.00	1.85	1.90
3	6.50	9.00	3.50	13.20	4.30	8.25	2.85	2.10	4.50	3.20	1.85	1.95
4	6.00	10.60	3.50	11.90	4.15	7.20	2.80	2.05	4.30	3.00	1.85	1.95
5	5.50	11.00	3.40	10.40	4.00	5.75	2.80	2.00	3.65	2.90	1.80	2.20
6	5.00	12.00	3.00	10.30	3.95	5.00	2.75	2.20	3.30	2.75	1.80	2.10
7	4.25	11.90	3.20	9.00	3.90	4.80	2.75	4.10	3.05	2.60	1.80	2.00
8	3.95	11.50	3.10	7.25	3.75	4.30	2.70	4.80	3.00	2.50	1.85	2.00
9	3.70	9.90	3.10	6.50	3.60	4.20	3.50	4.25	2.90	2.30	1.85	2.10
10	3.60	9.60	3.40	5.60	3.45	6.20	4.00	3.50	2.85	2.30	1.80	2.10
11	6.50	9.90	5.50	5.00	3.25	6.00	3.50	2.90	2.75	2.25	1.80	2.05
12	14.10	9.60	6.50	4.80	3.15	5.00	2.90	2.75	2.70	2.30	1.80	2.00
13	15.70	8.90	7.50	4.80	3.10	4.25	2.50	2.60	2.65	3.00	1.80	2.00
14	15.40	7.60	7.00	6.50	3.10	3.75	2.40	3.20	2.65	2.80	1.75	2.90
15	15.10	6.50	6.30	7.50	3.00	3.75	2.35	3.20	2.60	2.70	1.75	11.50
16	14.90	5.80	5.25	8.30	2.95	3.80	2.20	3.40	2.85	2.50	1.80	12.00
17	14.30	5.45	4.25	7.80	2.95	3.80	3.15	5.30	3.90	2.45	1.80	12.50
18	13.90	5.00	3.75	6.50	2.90	4.90	2.90	9.60	5.60	2.60	1.80	12.40
19	13.30	4.80	3.55	10.50	2.90	5.00	2.90	9.65	6.30	2.40	1.80	11.00
20	11.30	4.60	3.55	14.00	2.85	4.50	3.20	10.00	7.50	2.35	1.75	10.20
21	8.30	4.35	5.75	14.50	4.00	3.90	3.00	11.50	7.20	2.30	1.75	9.20
22	6.25	4.20	3.70	14.30	8.20	3.60	2.95	11.00	6.00	2.30	1.75	8.00
23	5.30	4.00	3.50	13.50	9.90	3.50	2.90	11.50	4.50	2.25	1.75	4.50
24	4.60	3.90	4.30	12.50	10.75	3.28	2.75	12.50	3.30	2.20	1.85	3.60
25	5.30	3.85	13.90	11.30	11.85	3.15	2.70	12.90	3.00	2.10	1.90	4.10
26	5.80	3.65	15.90	9.90	11.90	3.00	2.60	12.40	2.70	2.10	2.10	4.60
27	6.30	3.75	15.20	7.90	11.80	2.90	2.40	12.00	2.60	2.10	2.00	5.10
28	6.40	3.60	14.70	6.80	11.00	3.00	2.20	11.50	2.50	2.05	2.00	6.50
29	5.85	.....	14.25	5.90	9.60	2.90	2.30	9.95	2.65	2.05	1.85	11.50
30	5.50	.....	14.60	5.20	6.20	3.10	2.40	8.35	2.60	2.00	1.85	15.60
31	5.80	.....	15.50	.....	4.60	.....	2.20	6.85	.....	1.95	.....	16.00

COOSA RIVER AT LOCKS NOS. 4 AND 5, ALABAMA.

Records of gage heights at these stations are kept by the United States Engineer Corps, who have kindly furnished copies to the Geological Survey. Records of gage heights at Lock No. 5 during the year 1901 are not available. The records for Lock No. 4 are given in the accompanying table. Discharge measurements are not made at either of these stations. The stations are described in Water-Supply Paper No. 48, page 165.

Daily gage height, in feet, of Coosa River at Lock No. 4, Alabama, for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	7.00	7.00	3.80	16.50	5.10	6.40	3.20	2.20	6.50	2.60	1.60	1.6
2	7.60	7.60	3.80	16.20	4.90	9.40	3.20	2.30	5.70	4.50	1.60	1.5
3	7.80	8.00	4.10	15.30	4.60	9.60	3.60	2.00	5.10	3.30	1.60	1.7
4	7.10	11.50	3.90	13.00	4.40	8.50	3.30	1.90	4.70	3.10	1.60	1.8
5	6.20	12.90	3.80	12.20	4.30	6.60	3.00	1.70	4.10	3.20	1.60	1.9
6	5.40	14.00	3.60	11.50	4.20	6.30	2.70	1.70	3.50	3.00	1.60	2.1
7	4.90	13.80	3.60	10.00	4.10	5.70	2.60	1.80	3.30	2.70	1.60	2.3
8	4.40	13.10	3.40	8.80	4.00	5.00	2.60	3.40	3.20	2.40	1.60	2.2
9	4.10	11.20	3.40	7.30	3.90	6.20	4.00	4.80	3.00	2.30	1.60	2.1
10	3.90	10.70	3.70	6.40	3.80	6.40	4.40	5.00	2.90	2.20	1.60	2.1
11	7.00	10.70	6.40	5.80	3.60	5.50	3.40	3.50	2.80	2.10	1.50	2.1
12	17.50	10.40	8.60	5.30	3.50	4.60	2.70	2.70	2.70	2.00	1.50	2.2
13	18.10	10.00	8.90	5.20	3.50	4.10	2.40	2.60	2.80	2.30	1.50	2.6
14	17.60	9.00	8.10	7.30	3.40	3.90	2.20	3.50	2.90	2.20	1.60	4.4
15	17.40	7.50	6.90	8.70	3.40	4.00	2.10	3.40	2.70	2.40	1.60	12.9
16	17.00	6.70	5.60	9.70	3.30	4.10	2.00	3.50	2.70	2.40	1.60	13.3
17	16.70	6.10	4.70	9.30	3.20	4.40	2.00	5.70	4.00	2.40	1.60	13.5
18	16.50	5.80	4.30	8.00	3.00	5.60	2.70	10.50	6.70	2.50	1.60	12.9
19	15.80	5.50	4.00	11.80	3.10	5.40	2.50	10.80	7.50	2.30	1.50	11.9
20	12.70	5.20	4.00	16.00	3.10	4.80	3.70	12.00	8.70	2.00	1.50	10.7
21	10.90	5.00	4.30	16.80	4.50	4.40	3.60	13.90	8.40	1.90	1.60	9.6
22	6.00	4.70	4.10	16.40	8.90	4.00	3.00	12.20	6.40	1.90	1.70	6.5
23	5.20	4.60	4.00	15.50	11.00	3.60	3.00	13.20	4.50	1.90	1.70	4.2
24	5.00	4.30	4.60	14.40	12.40	3.40	2.60	14.40	3.60	1.80	1.80	4.0
25	5.90	4.10	4.70	12.90	13.20	3.60	2.50	14.20	3.20	1.80	1.80	4.4
26	6.20	4.10	16.40	11.20	13.70	3.10	2.40	14.00	3.00	1.80	1.80	4.6
27	6.90	4.00	18.00	8.80	13.70	3.00	2.10	13.70	2.80	1.70	2.00	6.1
28	7.40	3.80	17.60	6.70	12.90	3.00	2.00	13.20	2.70	1.70	1.90	6.8
29	6.80	.....	16.70	5.90	10.80	3.10	1.90	10.90	2.60	1.70	1.80	12.7
30	6.40	.....	16.40	5.50	7.20	3.20	2.20	9.50	2.60	1.70	1.60	16.9
31	6.60	.....	17.30	.....	5.40	.....	2.40	7.70	.....	1.60	.....	18.1

TALLADEGA CREEK AT NOTTINGHAM, ALA.

This station is located on the Southern Railroad bridge a fourth of a mile from the station at Nottingham, Ala., and 1 mile north of Alpine, Ala. The gage, which is graduated to feet and tenths and is 20 feet long, is fastened vertically to a tree on the right bank about 50 feet above the bridge. The initial point of sounding is at right-bank end of iron bridge on the upstream side. The bench mark is the top rail on the upstream side of the bridge, and is 24.13 feet above gage datum. The observer is R. M. McClatchy, station agent at Nottingham.

The station is described in Water-Supply Paper No. 48, page 173.

The following measurements were made during 1901 by James R. Hall and others:

April 5: Gage height, 3 feet; discharge, 526 second-feet.
October 22: Gage height, 1 foot; discharge, 90 second-feet.

Daily gage height, in feet, of Talladega Creek at Nottingham, Ala., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.20	2.30	2.00	3.40	2.20	2.00	1.50	1.10	1.20	1.10	1.00	1.00
2	2.80	2.10	2.00	5.90	2.20	2.00	1.40	1.00	1.20	2.80	1.00	1.40
3	3.20	3.80	2.00	4.50	2.10	2.00	1.30	1.00	1.20	2.50	1.00	1.30
4	2.70	8.00	2.00	3.40	2.00	1.80	1.30	1.00	1.10	1.50	1.00	1.20
5	2.40	3.90	1.80	3.00	2.00	1.70	1.30	1.00	1.10	1.30	1.00	1.20
6	2.20	3.20	1.80	2.90	1.90	1.70	1.40	1.00	1.10	1.20	1.00	1.30
7	2.10	2.80	1.80	2.60	1.90	3.00	1.40	1.00	1.10	1.10	1.00	1.10
8	2.10	2.80	1.80	2.50	1.90	1.90	1.30	1.00	1.10	1.10	1.00	1.00
9	2.00	3.30	1.80	2.30	1.90	1.70	1.30	1.00	1.00	1.10	1.00	1.00
10	1.90	2.80	2.00	2.20	1.90	1.60	1.20	1.00	1.00	1.00	1.00	1.10
11	5.80	2.60	1.90	2.10	1.90	1.50	1.20	1.00	1.00	1.00	1.00	1.10
12	8.80	2.70	1.80	2.10	1.90	1.50	1.20	1.10	1.00	1.00	1.00	1.00
13	4.70	2.50	1.80	2.70	2.00	1.60	1.20	1.00	1.00	1.00	1.00	1.00
14	3.40	2.30	1.80	3.70	1.90	1.80	1.20	1.00	1.00	1.00	1.00	2.40
15	2.90	2.20	1.80	2.70	1.90	1.70	1.20	1.00	1.00	1.00	1.00	3.50
16	2.60	2.20	1.70	2.50	1.90	1.60	1.20	2.30	1.00	1.00	1.00	1.70
17	2.70	2.20	1.70	2.30	1.80	1.50	1.20	2.20	3.40	1.00	1.00	1.50
18	2.40	2.10	1.70	2.40	1.70	1.40	2.00	1.90	2.80	1.00	1.00	1.30
19	2.20	2.10	1.70	11.20	1.90	1.40	1.50	1.70	1.60	1.00	1.00	1.20
20	2.20	2.00	1.80	6.30	2.50	1.40	1.30	1.50	1.50	1.00	1.00	1.10
21	2.10	2.00	2.10	4.10	3.90	1.40	1.30	1.40	1.40	1.00	1.00	1.10
22	2.20	2.00	2.00	3.40	2.50	1.30	1.20	1.30	1.30	1.00	1.10	1.10
23	2.20	2.00	1.80	3.10	2.00	1.30	1.20	1.20	1.30	1.00	1.20	1.10
24	2.20	2.10	2.60	2.80	1.80	1.30	1.20	1.20	1.20	1.00	1.30	1.10
25	2.20	2.10	2.80	2.70	1.70	1.30	1.20	1.50	1.20	1.00	1.20	1.30
26	2.30	2.10	8.90	2.60	1.70	1.30	1.20	1.30	1.10	1.00	1.10	1.20
27	2.20	2.00	4.60	2.50	1.70	1.30	1.20	1.40	1.10	1.00	1.10	1.10
28	2.20	2.00	3.30	2.40	1.70	1.30	1.20	1.50	1.10	1.00	1.00	1.20
29	2.20	.....	2.80	2.30	1.70	1.30	1.20	1.40	1.10	1.00	1.00	8.40
30	2.60	.....	2.90	2.20	1.70	1.40	1.20	1.30	1.10	1.00	1.00	7.50
31	2.50	.....	5.50	.....	2.20	.....	1.20	1.20	.....	1.00	....	3.50

ALABAMA RIVER AT MONTGOMERY, ALA.

This station was established by the United States Engineer Corps a number of years ago, at the Montgomery wharf, near the union passenger station at the foot of Commerce street. The readings are now taken by the Weather Bureau, and copies are furnished to the Geological Survey. The station is described in Water-Supply Paper No. 48, page 169. No discharge measurements were made in 1901.

Daily gage height, in feet, of Alabama River at Montgomery, Ala., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	13.50	10.00	7.20	36.50	8.50	10.50	5.00	2.20	12.00	3.00	1.40	1.80
2	18.20	10.40	6.80	37.00	8.00	12.00	5.00	2.50	9.50	3.80	1.40	1.60
3	19.00	11.00	6.60	37.40	7.70	14.50	4.80	3.00	8.40	6.50	1.40	1.80
4	18.80	19.50	6.50	37.20	7.40	15.00	4.80	2.80	5.90	6.70	1.30	2.30
5	16.20	27.50	6.40	35.20	7.20	14.50	4.80	2.50	5.20	5.20	1.60	2.20
6	13.40	30.00	6.20	31.50	6.90	13.00	4.60	2.30	4.50	4.60	1.70	2.20
7	10.60	29.80	6.00	26.00	6.60	11.80	4.80	2.70	3.80	3.60	1.50	2.20
8	8.70	28.00	5.80	22.50	6.20	13.00	4.90	2.60	2.80	3.00	1.50	2.20
9	8.00	26.80	5.50	17.50	6.00	10.00	4.60	2.40	2.50	2.60	1.50	2.40
10	7.00	26.10	6.00	13.50	5.80	8.50	4.40	3.60	2.40	2.50	1.50	2.40
11	6.80	25.00	7.80	11.50	5.50	8.00	4.90	4.70	2.20	2.40	1.20	2.30
12	23.50	22.00	8.60	9.50	5.50	6.80	4.60	4.30	2.00	2.40	1.20	2.30
13	33.00	21.50	10.60	9.00	5.50	6.50	4.20	3.60	2.00	2.40	1.50	2.30
14	37.00	19.80	11.50	9.50	5.60	6.00	2.40	3.00	2.80	2.40	1.40	2.30
15	37.60	17.00	12.20	11.50	5.60	5.50	2.20	3.00	4.10	2.40	1.30	6.70
16	36.60	14.00	10.20	14.00	5.20	5.50	2.00	4.00	4.00	2.40	1.30	16.50
17	35.00	12.60	9.20	15.20	4.70	5.20	2.50	6.80	3.80	2.40	1.30	19.80
18	33.00	9.80	8.00	14.20	4.70	5.00	4.80	9.60	4.30	2.40	1.30	19.60
19	30.80	9.00	6.80	20.80	4.60	6.50	5.50	12.00	8.30	2.60	1.60	18.00
20	27.00	9.10	7.00	29.50	4.60	6.80	5.00	15.50	9.70	2.50	1.80	16.00
21	24.50	8.60	8.10	33.80	5.60	6.20	4.80	16.50	10.00	2.30	1.80	14.50
22	18.50	8.30	8.00	34.20	10.00	5.60	4.80	17.80	10.50	2.20	1.90	12.30
23	12.50	8.00	7.50	33.80	15.00	5.00	4.20	17.90	8.30	2.00	2.00	10.00
24	8.80	8.00	8.50	29.80	17.50	4.70	3.80	20.10	6.00	2.00	2.00	6.50
25	9.80	7.80	11.50	26.50	18.00	4.50	3.50	23.00	5.00	1.80	2.00	5.10
26	9.80	7.70	14.00	23.00	19.00	4.30	3.20	22.50	2.50	1.80	2.00	4.60
27	9.80	7.50	24.50	19.50	20.00	4.10	3.00	20.00	2.00	1.70	1.90	5.00
28	10.00	7.50	29.80	15.00	19.80	3.90	2.50	18.80	2.00	1.60	1.80	5.50
29	10.30	.....	31.00	11.50	18.20	3.70	2.20	18.00	2.50	1.60	1.90	13.50
30	10.00	.....	30.50	9.50	15.00	4.50	2.20	17.20	3.00	1.50	1.90	29.80
31	9.80	.....	33.50	.....	12.00	.....	2.20	13.50	.....	1.50	.....	41.90

ALABAMA RIVER AT SELMA, ALA.

This station was originally established by the United States Engineer Corps. Readings are now taken by the United States Weather Bureau. During 1901 the following measurements were made by Max Hall and others:

March 14: Gage height, 14.20 feet; discharge, 35,518 second-feet.
April 25: Gage height, 34.00 feet; discharge, 90,332 second-feet.
August 9: Gage height, 4.35 feet; discharge, 12,509 second-feet.
October 30: Gage height, 1.10 feet; discharge, 7,710 second-feet.

Daily gage height, in feet, of Alabama River at Selma, Ala., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	16.00	13.00	11.30	35.60	12.00	19.00	1.00	2.80	17.00	4.30	1.40	1.80
2	21.00	13.00	9.80	36.50	10.40	17.00	2.00	2.60	13.80	4.30	1.40	1.80
3	24.00	13.60	9.50	37.40	10.00	16.50	2.40	2.60	10.60	5.00	1.40	1.90
4	24.60	17.00	9.30	38.50	9.60	18.50	6.60	2.80	8.80	7.40	1.50	2.30
5	24.00	24.90	9.60	38.40	8.20	19.00	6.00	3.00	8.00	7.90	1.50	2.30
6	23.00	30.10	9.60	37.20	7.00	19.80	5.60	2.80	7.40	6.40	1.40	2.30
7	18.00	33.00	9.40	35.50	7.00	18.50	5.60	6.60	6.00	5.80	1.60	2.40
8	15.00	35.10	8.00	33.00	6.80	17.40	5.50	4.60	5.20	5.00	1.60	2.10
9	13.30	35.60	7.70	28.00	6.40	16.10	5.50	4.20	4.40	4.30	1.50	2.00
10	10.00	35.70	7.90	22.60	6.00	14.80	5.50	3.40	4.40	3.40	1.50	2.20
11	8.10	33.00	9.00	17.40	5.00	12.00	5.20	4.00	3.60	2.90	1.50	2.40
12	16.50	31.40	10.20	14.00	5.00	11.00	5.20	5.30	3.40	2.80	1.50	2.40
13	28.00	31.20	12.00	12.00	4.80	9.50	5.10	6.20	3.20	2.60	1.40	2.40
14	34.00	27.00	14.10	11.80	4.50	8.00	4.40	4.40	3.70	2.50	1.40	2.60
15	38.00	26.00	15.40	12.00	4.00	7.60	3.70	3.80	4.30	2.20	1.40	5.00
16	39.50	20.60	15.00	15.00	3.80	7.00	3.70	6.00	4.00	2.50	1.30	10.00
17	40.00	16.90	14.80	16.50	3.40	6.10	3.50	7.40	5.00	2.50	1.30	18.00
18	39.00	14.60	12.00	17.30	3.20	6.00	4.30	11.00	5.00	2.40	1.30	21.60
19	37.50	13.10	11.10	22.00	3.00	5.00	6.30	12.00	5.50	2.00	1.40	22.00
20	35.00	12.60	10.50	28.60	3.00	4.10	7.30	16.00	9.50	2.30	1.60	21.50
21	32.40	12.00	11.00	35.00	3.50	3.40	6.00	17.60	11.40	2.50	1.80	18.70
22	29.00	11.80	11.90	38.00	4.70	3.00	5.50	18.80	11.50	2.50	1.80	15.00
23	21.00	11.70	12.20	39.00	9.40	3.00	5.40	20.00	11.20	2.20	1.80	14.20
24	22.00	11.60	13.00	38.00	17.00	2.60	5.40	20.90	10.00	2.00	1.80	12.00
25	14.00	11.20	14.70	35.80	19.00	2.20	4.40	22.80	7.50	2.00	1.90	11.00
26	12.80	11.50	17.00	31.90	20.00	2.00	4.00	24.60	6.00	2.00	1.90	7.10
27	12.80	11.40	22.50	28.00	20.90	1.50	4.00	24.80	4.40	1.80	2.00	6.20
28	12.70	11.30	27.60	24.20	22.00	1.30	3.60	22.90	4.00	1.60	2.00	6.00
29	12.70	.....	31.00	19.50	21.80	1.20	2.90	21.00	4.00	1.50	2.00	11.00
30	13.00	.....	33.00	15.00	20.70	1.20	2.90	20.60	4.20	1.30	1.80	23.00
31	13.00	.....	34.50	.....	19.50	.....	2.80	19.50	.....	1.30	.....	35.00

CAHABA RIVER AT CENTERVILLE, ALA.

The station was established August 7, 1901, and is situated at the iron highway bridge one-fourth mile west of Centerville, Ala. The bridge is a single span supported by tubular iron piers.

The gage is a wire fastened to the timber fencing along the downstream side of the bridge. The pulley is 100 feet from the initial point, which is the end of the iron bridge on left bank, downstream side. The bench mark is the top of the iron crossbeam under bridge floor nearest the gage pulley and is 42.85 feet above the datum of gage.

The observer is S. D. Hall. The following discharge measurements were made during the year 1901 by J. R. Hall and K. T. Thomas:

March 29: Gage height, 3.70; discharge, 1,117 second-feet.
April 25: Gage height, 5.50; discharge, 1,925 second-feet.
August 7: Gage height, 1.30; discharge, 399 second-feet.

Daily gage height, in feet, of Cahaba River at Centerville, Ala., for 1901.

Day.	Aug.	Sept.	Oct.	Nov.	Dec.	Day.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	2.20	2.10	1.20	1.40	17	7.70	2.10	1.30	1.30	12.30
2	.....	2.00	2.00	1.20	1.30	18	8.10	2.60	1.30	1.30	4.40
3	.....	1.90	1.80	1.20	1.60	19	9.10	3.90	1.30	1.70	3.60
4	.....	1.80	1.40	1.20	1.90	20	10.60	4.10	1.30	1.60	3.10
5	.....	1.60	2.30	1.20	1.80	21	14.70	2.00	1.30	1.60	2.90
6	.....	1.50	4.60	1.10	1.60	22	10.30	1.90	1.30	1.50	2.60
7	1.30	1.40	3.10	1.10	1.70	23	7.90	1.80	1.30	1.60	2.50
8	1.30	1.40	2.60	1.10	1.60	24	5.60	1.60	1.20	1.60	2.60
9	1.20	1.40	2.30	1.20	1.70	25	4.80	1.50	1.20	1.50	2.70
10	1.20	1.40	1.90	1.20	2.10	26	4.10	1.40	1.20	1.50	2.70
11	1.20	1.30	1.60	1.20	2.00	27	3.90	1.40	1.20	1.50	2.70
12	1.20	1.30	1.40	1.30	1.80	28	3.40	1.40	1.20	1.40	6.00
13	1.30	1.30	1.40	1.40	1.90	29	3.00	2.60	1.30	1.40	24.00
14	1.50	2.60	1.40	1.30	2.90	30	2.80	2.20	1.30	1.40	24.00
15	2.10	2.40	1.30	1.30	19.00	31	2.50	.....	1.30	.....	21.00
16	7.90	2.00	1.30	1.30	15.90						

MULBERRY FORK OF BLACK WARRIOR RIVER NEAR CORDOVA, ALA.

This station, which was originally established by the United States Weather Bureau, is at the Kansas City, Memphis and Birmingham Railroad bridge, three-fourths of a mile from Cordova, Ala. It is described in Water-Supply Paper No. 48, page 171. During 1901 the following measurements were made by Max Hall and K. T. Thomas:

List of discharge measurements of Mulberry Fork of Black Warrior River near Cordova, Ala.

Date.	Hydrographer.	Gage height.	Discharge.
1901.		*Feet.*	*Sec.-feet.*
January 8	Max Hall	1.30	1,781
February 18	K. T. Thomas	2.40	2,863
March 12	do	9.45	13,279
April 17	do	1.70	2,024
June 20	do	0.0	644
October 26	do	.40	385

Daily gage height, in feet, of Mulberry Fork of Black Warrior River, near Cordova, Ala., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.70	4.00	1.00	5.40	1.70	1.60	0.10	0.60	0.70	1.20	−0.40	−0.20
2	3.10	3.60	1.60	9.20	1.50	4.50	.30	− .60	.50	.80	− .50	− .20
3	2.80	7.35	2.30	14.50	1.30	2.80	.10	− .65	.40	.50	− .50	− .10
4	2.50	19.80	1.90	10.90	1.10	2.10	.00	− .65	.20	.40	− .40	.00
5	2.30	18.00	1.60	7.00	1.00	2.00	− .20	− .70	.10	.30	− .40	+ .10
6	2.00	9.10	1.80	5.80	.80	2.60	− .20	− .70	.00	.20	− .40	.10
7	1.70	5.60	1.50	4.90	.70	2.70	− .30	− .70	− .10	.10	− .30	.10
8	1.50	5.20	1.30	4.20	.60	2.00	− .30	− .65	− .20	− .00	− .30	.10
9	1.30	7.10	1.50	3.50	.50	1.50	− .40	− .60	− .30	− .10	− .40	.10
10	2.60	8.10	17.50	2.80	.40	1.10	− .50	− .60	− .40	− .20	− .40	.70
11	19.90	6.20	20.50	2.30	.30	2.20	− .60	− .60	− .50	− .20	− .40	1.20
12	32.50	5.40	10.80	2.10	.40	1.50	− .60	− .30	− .30	− .20	− .30	1.00
13	29.85	4.80	6.20	1.80	.60	1.10	− .60	+ .40	− .30	.00	− .30	.80
14	17.85	4.20	5.30	2.50	3.10	1.00	− .70	.10	+ .50	+1.10	− .30	6.20
15	9.25	3.80	4.20	2.80	1.80	.90	− .70	.20	.70	.60	− .30	2.40
16	6.80	3.30	3.50	2.30	1.30	.70	− .70	5.00	.50	.30	− .40	1.52
17	5.50	2.90	2.80	1.80	.90	.60	− .60	12.10	3.80	.10	− .40	8.10
18	4.30	2.60	2.20	2.20	.70	.50	− .00	6.80	5.00	.00	− .40	5.30
19	3.80	2.20	1.90	9.40	.90	.30	+1.10	10.80	3.50	− .10	− .20	3.50
20	3.10	2.00	2.40	16.10	1.80	.20	2.80	8.70	1.80	− .20	.00	2.60
21	2.80	1.80	5.00	11.50	5.80	− .00	1.60	8.50	1.10	− .20	− .10	2.00
22	2.60	1.60	4.20	6.80	7.30	− .10	.50	11.20	.80	− .30	− .10	1.50
23	2.40	1.30	3.50	5.40	5.50	− .20	− .00	7.30	.50	− .30	.00	1.50
24	2.60	1.40	3.50	4.50	3.60	− .30	− .20	5.20	.40	− .40	− .10	2.00
25	5.40	1.20	4.95	3.60	2.80	− .30	− .30	4.00	.30	− .40	− .20	2.50
26	5.00	1.20	11.20	3.00	2.10	− .30	− .40	2.80	.20	− .40	− .20	2.10
27	3.80	1.10	6.90	2.60	1.60	− .40	− .50	2.00	.10	− .40	− .10	2.60
28	4.20	1.00	5.80	2.20	1.30	− .40	− .50	1.50	.10	− .40	− .10	5.00
29	3.80	.....	4.60	2.00	1.10	− .40	− .50	1.40	1.00	− .50	− .20	18.50
30	3.60	.....	4.00	1.90	1.00	− .50	− .55	1.20	2.30	− .50	− .20	22.00
31	4.20	.....	6.20	.....	1.00	.....	− .60	1.00	.....	− .50	.....	13.50

BLACK WARRIOR RIVER AT TUSCALOOSA, ALA.

A continuous record of the gage heights at Tuscaloosa has been kept by the United States Engineer Corps since 1889. During 1895 and 1896 a number of discharge measurements were made, from which a rating table was established. Since that time measurements of flow and computations of the discharge have been made regularly by the United States Geological Survey. The station is described in Water-Supply Paper No. 48, page 170. The records are furnished by R. C. McCalla, jr., United States assistant engineer. Records of measurements during 1900 will be found in the Twenty-second Annual Report, Part IV, page 207. The following measurements were made during the year 1901 by K. T. Thomas:

February 1: Gage height, 15.10 feet; discharge, 9,300 second-feet.
March 15: Gage height, 18.72 feet; discharge, 9,461 second-feet.
June 27: Gage height, 1.77 feet; discharge, 828 second-feet.

Daily gage height, in feet, of Black Warrior River, at Tuscaloosa, Ala., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	19.50	15.10	7.50	28.00	9.40	6.50	1.70	0.70	6.11	5.40	0.85	1.60
2	19.00	14.80	7.30	26.50	8.50	12.25	1.73	.60	5.10	6.91	.80	1.50
3	17.90	15.00	8.40	32.60	7.90	16.65	2.00	.85	4.05	9.00	.75	1.40
4	14.70	35.20	9.65	35.10	7.30	14.80	2.30	1.00	3.60	6.72	1.00	1.40
5	13.00	42.00	9.70	31.50	7.00	12.00	2.50	.80	3.05	5.30	1.10	1.31
6	11.50	38.35	9.50	27.50	6.35	11.20	2.30	.75	2.81	1.50	1.10	1.95
7	10.25	32.15	9.00	24.30	6.15	11.10	2.50	.60	2.35	3.45	1.05	1.90
8	9.50	29.15	8.50	20.90	6.00	11.50	2.40	.50	2.04	3.02	1.00	2.58
9	8.75	28.05	8.05	17.90	5.70	9.40	2.25	.35	1.90	2.50	.95	2.60
10	8.30	30.97	8.70	14.50	5.60	7.60	2.10	.25	1.70	2.31	.90	3.80
11	17.40	29.75	29.50	12.50	5.00	6.50	2.00	.20	1.50	2.10	.90	5.00
12	52.70	27.45	34.00	11.00	4.60	6.20	1.70	.65	1.41	1.95	.85	5.80
13	56.50	25.15	28.50	10.00	5.00	6.40	1.30	.65	1.30	3.41	1.00	5.70
14	53.25	22.50	23.50	11.35	6.60	5.50	.90	.80	2.52	3.30	1.05	7.40
15	47.25	19.60	19.70	12.80	8.70	5.05	.70	1.20	6.70	3.95	1.00	31.00
16	41.45	17.45	16.00	13.00	8.30	4.80	.60	5.70	8.00	3.80	.98	40.75
17	36.30	15.70	13.00	11.70	6.80	4.50	.43	17.00	6.10	3.51	.90	35.00
18	31.85	13.70	11.05	12.80	5.50	4.10	2.60	26.30	12.21	3.00	.93	27.00
19	28.15	12.50	10.00	25.70	4.70	3.80	4.00	22.70	16.00	2.70	1.10	21.50
20	25.15	11.90	9.60	39.80	4.90	3.35	5.70	25.70	14.50	2.30	1.30	16.41
21	22.50	10.90	13.00	42.60	8.39	3.00	7.33	32.10	10.60	2.00	1.40	12.10
22	19.85	9.95	16.50	38.00	17.30	2.75	6.00	32.50	7.50	1.81	1.70	9.95
23	17.55	9.20	15.70	32.80	19.80	2.30	4.50	31.97	5.70	1.61	2.00	7.00
24	15.35	8.75	14.00	28.41	17.50	2.20	3.20	26.80	4.51	1.45	2.05	6.80
25	14.60	8.65	13.80	24.40	14.10	2.00	2.50	22.40	3.90	1.31	2.00	7.30
26	13.00	8.50	28.50	21.00	11.30	1.97	2.00	18.30	3.40	1.20	1.95	8.34
27	17.20	8.20	37.25	17.90	9.30	1.85	1.50	14.10	2.91	1.05	1.95	9.00
28	15.50	7.90	34.50	14.90	8.15	1.70	1.05	9.85	2.60	.81	2.00	10.96
29	14.80	.....	29.00	12.50	7.00	1.65	.90	7.90	2.91	.55	1.95	36.30
30	15.10	.....	24.30	10.90	6.90	1.65	.80	7.41	4.80	.90	1.91	49.00
31	14.60	.....	24.85	.....	6.35	.....	.60	7.10	.....	.90	.....	49.00

TOMBIGBEE RIVER AT COLUMBUS, MISS.

This station is located about 1,000 feet below the highway bridge, 1½ miles from the Southern Railway station at Columbus. It is described in Water-Supply Paper No. 48, page 174. During 1901 the following measurements of discharge were made by K. T. Thomas:

March 11: Gage height, 12.33 feet; discharge, 19,425 second-feet.
April 16: Gage height, 1.10 feet; discharge, 3,926 second-feet.
June 25: Gage height, −2.50 feet; discharge, 698 second-feet.
October 30: Gage height, −3 feet; discharge, 657 second-feet.

Daily gage height, in feet, of Tombigbee River, at Columbus, Miss., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4.00	6.00	0.90	2.60	0.90	1.30	−1.60	3.20	−0.40	−2.30	3.00	2.20
2	3.70	5.90	.80	6.40	.50	3.10	−2.40	3.40	.90	2.00	3.00	2.20
3	3.20	6.80	2.20	8.00	.20	3.80	−2.40	3.50	1.30	2.20	3.00	2.30
4	2.60	12.30	2.40	7.10	.00	3.90	2.10	3.40	1.60	2.20	2.90	2.30
5	1.80	13.20	2.10	6.80	−.30	3.50	2.40	3.30	1.60	2.50	2.90	2.20
6	1.00	13.90	1.80	6.20	−.50	3.10	−1.60	3.20	1.90	2.50	2.90	2.20
7	.70	15.10	1.40	5.30	−.60	2.80	−2.60	−3.00	2.00	2.60	3.00	2.20
8	.10	15.90	1.20	4.00	.90	1.90	2.60	2.80	2.20	2.70	2.80	2.10
9	.00	15.60	1.00	2.90	−1.00	1.40	−2.70	2.80	2.30	2.70	2.80	2.00
10	.30	14.50	8.80	2.00	1.10	1.00	2.80	2.90	2.40	2.80	2.80	1.80
11	10.90	13.00	12.45	1.40	−1.20	−.10	2.80	2.90	2.50	2.80	2.70	1.10
12	16.90	12.50	14.00	.90	−1.20	.70	2.90	3.10	2.50	2.80	2.80	.50
13	19.40	12.40	17.80	.70	−.40	−1.00	3.00	3.00	2.40	2.60	2.80	.10
14	21.70	11.00	19.40	.70	+3.30	.90	3.10	3.20	2.10	2.50	2.80	4.50
15	22.70	8.90	19.00	.90	4.40	−.80	3.10	1.50	1.80	2.20	2.80	9.50
16	22.30	6.00	17.10	1.20	4.40	−.80	−3.20	+1.00	1.00	2.00	2.70	9.80
17	20.90	4.40	13.80	1.50	3.60	.80	3.20	11.00	.20	2.00	2.70	9.20
18	18.80	3.30	10.80	6.00	2.70	−1.00	−3.00	12.40	−2.50	2.20	2.70	9.80
19	16.00	2.70	8.00	11.80	2.10	1.20	3.00	12.40	3.40	2.30	2.60	10.00
20	13.60	2.20	6.30	12.40	2.10	−1.70	3.00	14.00	3.50	2.40	2.50	8.80
21	9.40	1.80	4.60	12.70	6.30	−2.00	2.00	15.60	2.60	2.50	2.40	5.90
22	6.20	1.50	3.50	13.50	6.70	2.20	1.90	15.90	1.40	2.60	2.20	4.80
23	3.80	1.26	3.20	13.50	6.30	2.40	2.30	14.80	.10	2.70	2.30	2.40
24	3.00	1.00	3.10	11.80	5.30	−2.50	−2.50	12.10	.60	2.80	2.10	1.40
25	5.90	1.00	2.80	8.20	4.00	2.50	2.60	8.90	1.20	2.90	2.00	.80
26	6.50	1.10	2.50	5.10	2.20	2.60	2.90	6.50	1.60	2.90	1.90	.70
27	6.30	1.20	2.20	3.40	1.50	2.60	3.00	4.10	1.90	2.90	1.80	1.10
28	6.00	1.00	1.90	2.50	1.80	2.60	3.10	2.00	2.10	2.90	1.80	1.00
29	5.80	.....	1.60	1.80	1.70	2.70	3.20	1.60	2.20	3.00	2.00	9.00
30	5.70	.....	1.40	1.30	1.20	2.60	3.30	1.10	−2.30	3.00	2.10	11.00
31	5.50	.....	2.30	.....	.90	.....	3.40	.30	.....	3.00	.....	9.60

TOMBIGBEE RIVER NEAR EPES, ALA.

A record of gage heights has been kept at this station for the last ten years by the Alabama Great Southern Railway Company. The station is described in Water-Supply Paper No. 48, page 175. During 1901 the following measurements were made by K. T. Thomas:

January 31: Gage height, 12.70 feet; discharge, 13,738 second-feet.
March 14: Gage height, 21.10 feet; discharge, 23,824 second-feet.
June 28: Gage height, 1 foot; discharge, 1,496 second-feet.
November 13: Gage height, 0.70 foot; discharge, 1,290 second-feet.

Daily gage height, in feet, of Tombigbee River near Epes, Ala., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	10.00	12.00	6.50	13.00	7.50	5.50	1.00	.....	5.50	1.50	0.70	1.70
2	10.00	10.50	6.50	13.50	7.00	6.00	1.00	.....	4.00	6.00	.70	1.70
3	9.00	16.80	9.00	15.50	6.00	7.00	1.00	.....	3.50	2.50	.70	1.70
4	8.00	21.50	9.00	18.00	5.00	9.00	1.00	.....	2.50	1.50	.00	3.50
5	7.00	25.50	8.50	17.00	4.50	9.00	1.00	.....	2.00	1.50	.00	2.00
6	6.00	26.50	7.00	16.00	5.00	11.00	1.00	.....	2.00	1.50	.00	2.00
7	5.50	27.50	6.50	15.00	4.00	12.00	1.00	.....	1.50	1.50	.00	2.00
8	5.00	29.00	6.50	14.00	3.50	10.00	1.00	.....	1.50	1.00	.00	3.50
9	4.50	30.50	6.50	11.00	3.50	8.00	1.00	.....	1.50	1.00	.70	5.90
10	4.00	31.00	13.00	9.50	3.00	6.50	1.00	.....	1.50	1.00	.70	6.50
11	18.00	31.00	18.00	8.00	3.00	5.50	.50	.....	1.50	1.00	.70	5.50
12	29.50	31.00	19.50	7.50	3.50	4.50	.50	.....	1.50	1.00	.70	4.70
13	33.00	30.00	20.00	9.00	4.00	4.00	.50	.....	1.00	1.00	.70	4.20
14	35.00	29.50	24.50	8.00	7.00	3.50	.50	.....	1.00	1.00	.70	13.00
15	36.00	28.50	25.50	7.00	8.00	3.50	.50	.....	1.00	1.00	.70	19.50
16	38.00	26.00	26.50	7.00	8.50	3.50	.50	8.50	1.50	1.00	.70	22.00
17	39.00	23.00	26.50	6.50	8.00	3.00	.50	15.00	2.00	1.00	1.00	23.00
18	39.50	16.00	26.00	20.00	7.00	3.00	.50	20.00	2.50	1.00	1.70	22.50
19	40.00	12.00	25.00	28.00	6.50	2.50	.50	22.50	6.00	1.00	1.70	22.00
20	40.50	10.00	23.00	29.50	9.00	2.00	1.00	23.00	.....	1.00	1.50	20.00
21	39.00	8.50	20.00	30.00	12.00	2.00	1.00	24.00	7.50	1.00	1.50	18.00
22	38.00	8.00	17.00	29.50	12.00	2.00	1.00	24.50	7.50	1.00	1.70	14.00
23	34.50	7.50	12.50	28.50	11.50	1.50	1.00	26.00	7.00	1.00	1.70	12.00
24	29.00	7.00	11.00	28.00	11.00	1.20	1.00	26.50	5.50	.50	1.80	9.00
25	24.50	6.50	12.00	27.00	10.00	1.00	1.00	26.00	4.00	.50	1.80	8.00
26	20.00	6.50	13.50	24.00	8.00	1.00	.50	25.00	3.00	.50	2.00	7.00
27	16.00	6.50	13.50	18.00	6.50	1.00	.50	23.00	2.00	.50	2.00	7.00
28	15.00	6.50	11.50	13.00	6.50	1.00	.50	19.00	1.50	.50	2.00	12.00
29	14.00	.....	10.00	11.00	6.50	1.00	.20	12.00	1.50	.50	1.90	20.00
30	13.00	.....	9.00	8.00	6.50	1.00	.20	6.50	1.50	.50	1.80	26.00
31	12.70	.....	13.50	.....	7.00	.....	.20	5.50	.....	.50	.....	27.00

PEARL RIVER AT JACKSON, MISS.

This station was established June 24, 1901, and is situated at the highway bridge 2 miles from the Union station of Jackson and one-eighth of a mile above the Alabama and Vicksburg Railway bridge.

The gage is a wire gage fastened to the guard timber on the downstream side of the bridge. The rod is 10 feet long, graded to feet and tenths, and is marked with staples and brass figures. Above 10 feet the guard timber is marked. The bench mark is the downstream end of the top of the iron crossbeam 120 feet from the right-bank end of the bridge, which latter is the initial point for soundings. The elevation of the bench mark is 39 feet above datum. The bridge floor at the same point is 40.15 feet above datum.

The observer is James Hurst. The following discharge measurements were made during 1901 by K. T. Thomas:

June 24: Gage height, 2.10 feet; discharge, 430 second-feet.
August 15: Gage height, 5.85 feet; discharge, 1,880 second-feet.
October 28: Gage height, 1.55 feet; discharge, 262 second-feet.

Daily gage height, in feet, of Pearl River at Jackson, Miss., for 1901.

Day.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	1.90	1.50	5.90	1.90	1.40	3.50
2	.....	1.70	1.50	5.70	1.80	1.30	3.30
3	.....	1.80	1.50	5.60	1.60	1.30	3.40
4	.....	1.80	1.40	5.40	1.40	1.40	3.20
5	.....	1.70	1.30	5.20	1.50	1.20	3.30
6	.....	1.80	1.30	4.70	1.60	1.00	3.30
7	.....	1.80	1.20	3.90	1.50	1.30	3.20
8	.....	1.80	1.20	3.50	1.50	1.50	3.40
9	.....	1.80	1.20	3.20	1.40	1.80	3.90
10	.....	1.80	1.20	3.00	1.40	1.80	4.20
11	.....	1.80	1.20	2.00	1.30	1.60	5.40
12	.....	1.80	1.20	2.60	1.40	1.60	5.80
13	.....	1.80	1.30	2.50	2.00	1.60	6.40
14	.....	1.60	1.40	2.30	3.00	1.60	10.00
15	.....	1.80	1.60	2.30	3.40	1.50	14.90
16	.....	1.70	1.80	2.50	3.40	1.50	15.00
17	.....	1.70	2.10	2.80	3.00	1.50	15.20
18	.....	1.70	2.60	3.40	2.10	1.50	15.90
19	.....	1.70	3.70	3.40	2.30	1.50	15.40
20	.....	1.60	4.50	3.60	2.10	1.60	15.00
21	.....	1.70	6.00	3.80	2.00	1.60	14.60
22	.....	1.70	6.30	3.70	1.90	1.80	14.30
23	.....	1.70	7.40	3.50	1.80	1.90	13.20
24	2.10	1.80	7.40	3.10	1.80	2.10	12.60
25	2.10	2.20	7.30	2.20	1.70	2.40	12.70
26	2.00	2.00	7.30	2.40	1.70	2.70	11.90
27	2.00	1.90	7.40	2.50	1.60	3.30	11.30
28	1.90	1.90	7.60	2.50	1.60	3.50	10.60
29	2.00	1.80	6.90	2.30	1.60	3.70	13.60
30	2.10	1.80	6.90	2.10	1.50	3.70	14.60
31	.....	1.60	6.70	.....	1.40	.....	15.00

EASTERN MISSISSIPPI RIVER DRAINAGE.

YAZOO RIVER AT YAZOO CITY, MISS.

A gage has been maintained at this point by the Engineer Corps of the Army. It was replaced in 1901 by a new gage rod in three sections, marked with brass figures and brass tacks, the section being placed as follows: The lowest, marked from −3.0 to +4.5 feet, is attached to the protecting work of the bridge; the middle section, marked from 4.5 to 18.5 feet, is attached to the piling that protects the bridge pier; the uppermost section, continuing the gradation up to 32.3 feet, is on a post under the approach to the bridge. The highest known water occurred in 1882, reaching a gage height of 36.5 feet; the lowest occurred on October 15 to 17, and 20 to 22, 1896, with a gage height of −2.8 feet. The danger line is at 25 feet. A bench mark was established on the top of the upstream cylinder of the second pier from the left bank at a distance of 85 feet from the initial point for soundings, which is on the downstream end of iron bridge on left bank. The elevation of the mark is 35.85 feet above zero of the gage. Other important bench marks in Yazoo City are the following: P. B. M. 12, Yazoo City, is a copper bolt in stone under ground, surmounted by an iron pipe and cap, in the north corner of county courthouse yard. It is 44.1 feet above the zero of gage and 116.2 feet above mean sea level. P. B. M. 13, Yazoo City, is a copper bolt in stone under ground, surmounted by an iron pipe and cap, in north corner of public school yard, near Washington and Main streets. It is 29.2 feet above the zero of gage and 101.3 feet above mean sea level.

Discharge measurements are made by P. C. Battaile, from the city toll bridge, one-half mile northwest from the Illinois Central station.

The following measurements were made during 1901 by K. T. Thomas:

March 9: Gage height, 11.80 feet; discharge, 11,618 second-feet.
April 12: Gage height, 13.40 feet; discharge, 11,779 second-feet.
June 22: Gage height, 2.92 feet; discharge, 3,935 second-feet.

Daily gage height, in feet, of Yazoo River, at Yazoo City, Miss., for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	5.0	1.0	15.0	19.7	22.9	8.0	21.1	18.7	0.6	1.6	9.6	9.6
2	4.6	.7	15.0	19.5	22.9	9.5	21.2	18.2	.6	1.5	9.6	9.8
3	4.3	.4	15.0	19.2	22.9	8.1	21.3	17.8	.6	1.4	9.6	10.0
4	4.0	.4	15.3	18.8	22.9	8.3	21.4	17.4	.7	1.2	9.5	10.3
5	3.5	.4	15.4	18.5	22.8	8.6	21.5	17.0	.7	.9	5.3	10.5
6	3.0	.3	15.4	18.1	22.7	9.4	21.6	16.5	.6	.6	9.2	10.8
7	2.4	.2	15.5	17.6	22.6	10.3	21.7	16.0	.4	.2	9.0	11.1
8	1.7	.2	16.0	17.0	22.4	11.0	21.9	15.5	.1	.1	8.8	11.5
9	1.2	1.1	16.1	16.4	22.3	11.5	22.0	14.7	.9	.3	8.5	11.7
10	.9	1.5	16.2	15.6	22.0	12.0	22.1	13.7	.9	.5	8.1	11.9
11	1.3	2.0	16.3	17.6	21.7	12.6	22.1	12.9	.8	.7	7.7	12.0
12	1.3	3.2	16.4	17.2	21.4	13.1	22.1	11.7	.8	.7	7.3	12.1
13	1.0	4.9	16.5	17.0	21.0	13.9	22.1	10.5	.7	.6	6.8	12.2
14	1.0	6.0	16.5	17.0	20.7	17.6	22.1	9.2	.6	.5	6.2	12.2
15	1.6	6.9	16.5	17.2	20.3	17.3	22.0	7.8	.5	.3	5.5	12.0
16	2.1	7.5	17.0	17.6	20.0	17.6	21.9	6.5	.4	.1	4.7	11.7
17	2.5	8.0	17.2	21.5	19.6	17.7	21.9	5.3	.3	.3	3.9	11.5
18	2.8	8.3	17.3	24.4	19.2	18.1	21.8	4.3	.2	.8	3.2	11.1
19	3.0	8.5	18.8	21.8	18.6	18.8	21.6	3.5	.1	.9	2.5	10.7
20	3.3	8.8	19.5	22.0	18.0	19.1	22.3	2.8	.1	1.0	2.1	11.8
21	3.5	9.9	19.5	22.0	17.4	19.8	22.0	2.4	.6	.9	1.6	11.1
22	3.6	10.5	19.8	22.0	16.6	20.0	21.5	2.0	.5	1.3	1.4	10.7
23	3.7	11.0	20.0	22.2	16.0	20.0	21.2	1.7	.5	1.4	2.2	10.5
24	3.7	11.4	20.2	22.2	15.0	20.2	20.0	1.4	.7	1.2	3.6	10.5
25	3.6	12.1	20.5	22.2	13.8	20.3	20.6	1.2	.0	1.9	5.0	10.5
26	3.4	12.4	20.5	22.2	12.7	20.5	20.5	1.0	.4	3.9	6.2	10.5
27	3.1	12.5	20.5	22.3	11.6	20.8	20.4	.9	.9	6.0	7.0	10.2
28	2.7	14.4	20.5	22.3	10.4	20.8	20.2	.8	1.3	7.1	8.0	10.8
29	2.3	.....	20.3	22.9	9.2	20.9	19.9	.7	1.5	8.0	8.6	11.1
30	1.8	.....	20.2	23.0	8.0	21.0	19.4	.6	1.6	8.7	9.1	11.4
31	1.4	.....	20.0	.....	7.1	.....	19.0	.6	.....	9.1	.....	11.7

Daily gage height, in feet, of Yazoo River at Yazoo City, Miss., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	11.8	16.8	16.4	16.5	16.6	9.0	−0.1	−1.4	9.1	7.4	−1.5	0.1
2	11.9	16.7	16.0	16.4	16.6	8.1	−.2	−1.4	8.9	7.3	−1.5	.1
3	12.1	17.7	15.6	16.2	16.5	7.6	−.3	−1.4	8.4	7.0	−1.5	.0
4	12.2	18.2	15.1	16.0	16.3	7.5	−.3	−1.3	7.8	6.9	−1.0	−.4
5	12.3	17.8	14.7	15.6	16.0	7.4	−.2	−1.0	7.0	6.8	−1.3	−.5
6	12.4	17.6	14.1	15.3	15.8	7.2	−.1	−.7	6.2	6.5	−1.4	−.5
7	12.4	17.6	13.4	14.9	15.6	7.5	+.1	−.8	5.3	6.0	−1.5	−.6
8	12.4	18.0	12.6	14.5	15.5	7.0	.3	−1.0	4.3	5.6	−1.5	−.8
9	12.4	17.7	11.8	14.2	15.4	6.5	.4	−1.2	3.4	4.8	−1.5	+2.1
10	12.4	17.8	12.0	13.9	15.2	6.1	.4	−1.3	2.5	4.0	−1.5	2.5
11	18.3	17.7	12.3	13.7	15.2	5.7	.3	−1.4	1.8	3.1	−1.5	2.3
12	18.2	17.9	12.4	13.6	15.2	5.4	.1	−.1	1.1	2.3	−1.6	2.8
13	17.6	17.9	12.6	13.4	15.2	5.0	−.3	−.3	1.0	1.7	−1.6	3.5
14	17.6	17.8	12.9	13.3	15.5	4.7	−.6	−.7	2.5	1.1	−1.7	6.7
15	17.8	17.7	13.0	13.1	15.5	4.5	−.9	+1.2	2.5	.7	−1.7	6.9
16	17.8	17.7	13.1	12.9	15.4	4.2	−1.0	2.0	3.0	.4	−1.8	7.3
17	17.8	17.7	13.3	12.8	15.4	4.1	1.2	1.2	3.5	.2	−1.8	8.0
18	17.8	17.6	13.5	14.4	15.4	3.9	−1.2	1.8	4.7	.0	−1.8	8.7
19	17.7	17.5	13.7	14.6	15.1	3.7	−1.2	2.6	5.9	−.3	−1.7	9.3
20	17.6	17.5	14.0	14.8	14.7	3.5	−1.2	3.8	7.0	−.5	−1.7	9.5
21	17.5	17.4	14.3	15.2	14.2	3.3	−.5	4.9	7.7	−.7	−1.7	9.7
22	17.4	17.3	14.7	15.5	13.2	3.0	−.3	5.6	8.2	−.7	−1.4	9.8
23	17.3	17.2	15.0	15.8	11.9	2.6	−.7	6.1	8.3	−.8	−.4	9.8
24	17.4	17.1	15.5	16.0	10.7	2.2	−.7	6.5	8.3	−.8	−.1	9.8
25	17.4	17.0	15.9	16.1	11.7	1.8	−.8	6.9	8.3	−.8	−.1	9.8
26	17.3	16.8	16.2	16.3	12.2	1.4	−.9	7.3	8.1	−.9	−.1	9.7
27	17.3	16.5	16.2	16.5	11.3	1.0	−1.0	8.4	8.0	−1.0	+.5	9.7
28	17.3	16.2	16.2	16.5	10.7	.6	−1.1	8.3	7.8	−1.1	.5	10.0
29	17.2	.....	16.3	16.6	10.2	.3	−1.2	8.8	7.7	−1.1	.6	11.6
30	17.1	.....	16.3	16.6	9.5	.1	−1.3	9.0	7.5	−1.3	.5	11.5
31	17.0	.....	16.6	.....	9.2	.....	−1.4	9.1	.....	−1.4	.....	11.4

YOUGHIOGHENY RIVER AT FRIENDSVILLE, MD.

This station, which was established by E. G. Paul on August 17, 1898, is located at the iron highway bridge connecting the east and west portions of the village. It is described in Water-Supply Paper No. 48, page 177. Results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 220. During 1901 the following measurements were made by E. G. Paul:

July 27, 1901: Gage height, 4.10 feet; discharge, 132 second-feet.
November 3, 1901: Gage height, 3.90 feet; discharge, 89 second-feet.

Daily gage height, in feet, of Youghiogheny River at Friendsville, Md., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	5.00	[a]5.00	5.00	5.30	5.50	6.30	4.40	4.00	4.10	3.90	3.90	4.40
2	4.90	[a]5.00	5.00	5.30	5.30	5.80	4.30	4.00	4.00	3.90	3.90	4.70
3	4.90	5.00	6.90	5.40	5.20	5.40	4.20	4.00	4.00	3.90	3.90	5.60
4	4.90	5.00	6.70	5.90	5.00	5.20	4.20	4.00	4.00	3.90	3.90	6.90
5	4.90	5.00	6.50	6.20	5.00	5.00	4.20	4.00	4.00	3.90	3.90	6.40
6	4.90	5.00	6.40	7.50	4.90	5.20	4.20	4.10	4.00	3.90	3.90	6.40
7	4.90	5.00	6.10	8.40	4.70	5.20	4.10	4.10	3.90	3.90	3.90	6.10
8	4.90	5.00	5.70	8.00	4.60	5.80	4.10	4.10	3.90	3.90	3.90	6.00
9	4.90	5.00	6.40	7.00	4.80	5.60	4.00	4.10	3.90	3.90	3.90	5.30
10	5.20	5.00	8.50	6.60	5.00	5.20	4.00	4.00	3.90	3.60	3.90	6.30
11	5.70	5.00	8.20	6.50	5.80	5.00	4.00	4.00	4.10	3.90	3.90	6.00
12	5.90	5.00	7.60	6.40	5.90	4.90	4.10	4.10	4.10	3.90	4.00	5.80
13	6.30	5.00	7.10	6.30	5.80	4.80	4.10	4.20	4.20	3.90	4.00	5.40
14	5.90	5.00	6.90	6.30	5.70	4.80	4.10	4.30	4.30	3.90	4.10	7.30
15	5.70	5.00	6.70	6.30	5.60	5.00	4.10	4.20	4.30	4.00	4.10	9.30
16	5.50	5.00	6.60	6.10	5.60	5.40	4.20	4.10	4.40	4.00	4.00	7.80
17	5.40	5.00	6.40	6.00	5.50	5.10	5.20	4.10	4.40	4.00	4.00	7.40
18	5.10	5.00	6.20	5.90	5.40	5.00	5.10	4.10	4.30	4.00	4.00	6.70
19	4.90	5.00	5.90	5.80	5.20	4.90	4.80	4.20	4.20	4.00	4.00	5.40
20	4.90	5.00	5.80	5.90	5.10	4.70	4.30	4.20	4.20	4.00	4.10	5.00
21	5.30	6.00	5.70	7.80	5.00	4.70	4.20	4.20	4.10	4.00	4.20	4.90
22	5.20	5.00	5.60	7.50	5.00	4.70	4.10	4.30	4.10	4.00	4.30	4.80
23	5.20	5.00	5.50	7.10	5.10	4.60	4.10	4.40	4.00	4.00	4.40	4.80
24	5.10	5.00	5.40	6.00	5.10	4.50	4.20	4.60	4.00	3.90	4.40	4.80
25	5.10	5.00	5.40	6.60	5.20	4.50	4.10	4.40	4.00	3.90	4.50	4.90
26	5.10	5.00	5.30	6.40	5.90	4.40	4.10	4.30	4.00	3.90	4.40	4.90
27	[a]5.00	5.00	5.30	6.10	7.00	4.60	4.10	4.20	3.90	3.90	4.40	4.90
28	[a]5.00	5.00	6.00	6.10	7.30	4.80	4.10	4.20	3.90	3.90	4.40	4.50
29	[a]5.00	.....	5.80	5.90	7.10	4.60	4.10	4.10	3.90	3.90	4.30	7.20
30	[a]5.00	.....	5.60	5.70	6.80	4.50	4.00	4.10	3.90	3.90	4.50	7.80
31	[a]5.00	.....	5.40	.....	6.50	.....	4.00	4.10	.....	3.90	.....	6.70

[a] Frozen.

INDIAN CREEK.

The following data relative to the run-off of Indian Creek watershed in Westmoreland and Fayette counties, Pa., from August, 1892, to July, 1893, were furnished by Charles H. Knight, of Rome, N. Y. The computations are based upon daily measurements at weirs of standard form, two weirs and two rain gages being used.

Estimated monthly discharge of Indian Creek, Pennsylvania.

[Drainage area, 120 square miles.]

Month.	Mean flow in second-feet.	Run-off.		Rainfall in inches.	Percentage of run-off to rainfall.
		Second-feet per square mile.	Depth in inches.		
1892.					
August	31.4	0.26	0.30	2.00	15.08
September	15.2	.13	.14	1.43	9.89
October	12.6	.105	.12	.34	35.55
November	48.8	.41	.46	3.50	12.99
December	102.8	.86	1.00	2.06	47.96
1893.					
January	193.5	1.61	1.86	2.89	64.34
February	659.0	5.50	5.72	5.94	96.31
March	290.5	2.42	2.79	.73	382.27
April	278.0	2.32	2.59	4.86	53.18
May	523.3	4.36	5.02	6.39	78.69
June	41.3	.34	.38	3.23	11.90
July	13.1	.11	.13	1.77	7.13
The year	181.3	1.51	20.5	35.14	58.34

CHEAT RIVER NEAR UNEVA, W. VA.

This station was established July 8, 1899, by E. G. Paul. It is described in Water-Supply Paper No. 48, page 177. The station was discontinued December 31, 1900, and the following discharge measurements were made during 1901 by E. G. Paul:

July 26: Gage height, 2.30 feet; discharge, 704 second-feet.
November 5: Gage height, 1.45 feet; discharge, 222 second-feet.

GREENBRIER RIVER AT ALDERSON, W. VA.

This station, which was established by C. C. Babb and D. C. Humphreys on August 1, 1895, is described in Water-Supply Paper No. 48, page 178. Records of measurements during 1900 will be found in the Twenty-second Annual Report, Part IV, page 221. During 1901 the following measurements were made by D. C. Humphreys:

March 27: Gage height, 3.45 feet; discharge, 3,139 second-feet.
July 30: Gage height, 1.73 feet; discharge, 276 second-feet.

Daily gage height, in feet, of Greenbrier River at Alderson, W. Va., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.37	2.32	2.10	2.80	2.95	3.85	3.52	1.77	2.65	1.75	1.45	1.63
2	2.53	2.20	2.10	2.85	2.83	3.43	3.25	1.72	2.95	1.73	1.38	1.63
3	2.55	2.25	2.10	4.75	2.80	3.15	3.00	1.68	2.55	1.64	1.45	1.66
4	2.35	2.60	2.10	7.05	2.63	2.93	3.33	1.63	2.33	1.63	1.45	2.15
5	2.25	2.65	2.85	5.33	2.50	2.80	3.63	1.64	2.18	1.62	1.50	3.35
6	2.18	2.43	4.40	5.23	2.43	2.65	3.37	1.70	2.03	1.60	1.50	2.83
7	2.25	2.25	3.40	6.55	2.37	2.90	3.95	2.40	1.98	1.60	1.46	2.50
8	2.23	2.40	3.05	5.45	2.33	3.00	3.45	2.52	1.92	1.60	1.45	2.32
9	2.18	2.50	2.98	4.50	2.33	3.33	2.97	2.25	1.90	1.60	1.47	2.20
10	2.12	3.05	3.00	4.00	2.48	2.98	2.65	2.04	1.85	1.58	1.46	2.20
11	2.25	3.25	5.80	3.40	3.45	2.75	2.45	1.90	1.85	1.55	1.45	2.58
12	9.33	3.03	6.80	3.35	3.13	2.50	2.30	1.95	1.83	1.53	1.45	3.20
13	6.55	2.85	4.65	3.30	3.00	2.42	2.20	2.35	2.60	1.55	1.60	2.80
14	4.63	2.60	3.90	3.45	2.92	2.46	2.13	2.05	2.30	1.58	1.52	2.60
15	3.85	2.47	3.58	6.61	2.75	2.58	2.17	3.03	2.10	1.60	1.50	13.32
16	3.40	2.45	3.33	5.40	2.63	4.80	2.38	2.68	1.98	1.61	1.50	7.42
17	3.05	2.50	3.05	4.60	2.52	8.95	2.45	2.42	1.90	1.62	1.50	4.75
18	2.92	2.50	2.85	4.38	2.45	5.95	2.38	2.30	2.10	1.62	1.50	3.70
19	2.55	2.53	2.70	4.10	2.49	5.05	2.45	2.20	3.10	1.63	1.50	3.25
20	2.52	2.25	2.63	7.11	2.48	4.10	2.33	2.08	2.60	1.64	1.50	2.95
21	2.25	2.65	2.65	9.10	2.50	3.55	2.30	2.53	2.30	1.65	1.48	2.68
22	2.35	2.30	3.17	6.50	8.38	3.25	2.20	2.55	2.15	1.65	1.47	2.30
23	2.54	2.42	3.30	5.30	8.40	3.40	2.08	2.38	2.04	1.66	1.45	2.30
24	2.55	2.45	3.06	4.93	5.70	6.84	1.98	2.27	1.92	1.66	1.50	2.30
25	2.70	2.50	2.90	4.44	4.25	4.80	1.90	2.25	1.88	1.66	1.60	2.35
26	2.90	2.35	2.85	4.17	3.65	3.80	1.93	2.20	1.85	1.67	1.80	2.45
27	2.87	2.25	3.40	3.88	8.01	3.55	1.90	3.30	1.77	1.63	1.89	2.45
28	2.85	2.10	3.30	3.62	8.75	3.90	1.75	3.05	1.75	1.58	1.80	2.45
29	2.85	.....	3.28	3.35	6.38	3.54	1.76	2.55	1.70	1.53	1.65	9.75
30	2.55	.....	2.98	3.10	5.40	4.20	1.73	2.30	1.70	1.47	1.67	11.10
31	2.52	.....	2.85	.....	4.45	.....	1.70	2.23	.....	1.50	.....	6.60

NORTH FORK OF NEW RIVER AT WEAVERSFORD, N. C.

This station was established July 27, 1900, and is described in Water-Supply Paper No. 48, page 179. On June 27, 1901, a measurement was made by N. C. Curtis, when the gage height was 1.40 feet and the discharge 1,377 second-feet.

Daily gage height, in feet, of North Fork of New River at Weaversford, N. C., for 1901.

Day.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	1.70	.40	1.80	.70	.20	.20
2	.....	.90	.20	1.70	.90	.20	.20
3	.....	.60	.10	1.30	1.00	.20	.60
4	.....	.80	.10	1.00	.70	.20	.40
5	.....	.70	2.35	.80	.80	.20	.30
6	.....	.60	5.75	.70	.50	.20	.30
7	.....	2.00	2.15	.60	.40	.20	.30
8	.....	.70	9.00	.50	.40	.20	.20
9	.....	.50	7.00	.50	.40	.20	.30
10	.....	.40	7.50	.70	.30	.20	.70
11	.....	.40	5.90	.70	.30	.20	.40
12	.....	.30	3.75	.70	.30	.20	.30
13	.....	.40	3.00	.60	1.40	.30	.30
14	.....	.30	3.70	.60	.50	.30	2.00
15	.....	.30	3.00	.60	.50	.20	7.60
16	.....	.40	3.15	.50	.40	.20	1.50
17	.....	1.20	3.40	.50	.40	.20	1.00
18	.....	1.50	2.60	.80	.40	.30	.80
19	.....	.70	2.00	.50	.30	.30	.60
20	.....	.60	2.60	.40	.30	.30	.60
21	.....	.30	3.00	.60	.20	.30	.40
22	.....	.20	2.60	.40	.20	.20	.40
23	.....	.20	1.25	.60	.20	.20	.40
23	.....	.20	3.00	.40	.20	.40	.30
25	.....	.20	1.00	.40	.20	.40	.30
26	.....	.70	1.50	.30	.20	.30	.60
27	1.00	.70	1.60	.30	.20	.30	1.50
28	1.00	.10	1.80	.70	.20	.30	1.60
29	.90	.10	1.80	1.40	.20	.30	10.50
30	1.00	.10	1.20	1.20	.20	.00	4.40
31	.....	.20	1.90	.....	.20	.....	3.40

SOUTH FORK OF NEW RIVER AT NEW RIVER, N. C.

This station was established July 28, 1900, and is described in Water-Supply Paper No. 48, page 180. A measurement was made June 27, 1901, by N. C. Curtis, when the gage height was 3.90 feet and the discharge 1,976 second-feet.

Daily gage height, in feet, of South Fork of New River at New River, N. C., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.75	2.55	2.60	3.05	3.40	3.95	2.85	4.80	3.80	2.95	2.70
2	2.70	2.50	2.60	4.45	3.30	3.70	2.80	4.30	3.70	2.90	2.70
3	2.70	2.55	2.55	5.65	3.30	3.60	2.75	4.10	3.70	2.90	3.15
4	2.65	2.80	2.50	4.25	3.25	3.70	2.70	4.05	3.50	2.90	3.15
5	2.60	2.70	2.50	3.70	3.30	3.65	3.95	3.85	3.40	3.00	2.95
6	2.55	2.50	2.50	3.60	3.30	4.05	9.47	3.70	3.30	2.95	2.85
7	2.50	2.55	2.50	3.55	3.20	3.65	5.30	3.65	3.25	2.90	2.75
8	2.50	2.70	2.50	3.40	3.20	3.55	4.00	3.60	3.20	2.90	2.70
9	2.50	3.05	2.50	3.10	3.55	3.45	3.55	3.60	3.15	2.90	2.80
10	2.55	2.95	2.60	3.05	3.45	3.30	3.35	3.60	3.10	2.90	3.80
11	3.20	2.80	3.15	3.00	3.65	3.20	3.35	3.55	3.10	2.90	3.40
12	3.55	2.65	2.95	2.95	3.45	3.20	4.65	3.55	3.10	2.90	3.00
13	3.50	2.60	2.70	3.05	3.20	3.15	6.25	3.60	4.90	2.90	2.90
14	2.95	2.60	2.65	3.80	3.00	3.20	5.60	3.60	4.20	2.85	5.90
15	2.90	2.60	2.60	3.40	3.00	3.25	5.60	3.60	3.25	2.80	13.00
16	2.80	2.60	2.60	3.10	3.00	3.40	5.35	3.60	3.10	2.80	5.40
17	2.80	2.60	2.60	3.05	3.00	3.50	7.20	3.60	3.10	2.80	4.30
18	2.70	2.60	2.50	3.00	3.10	3.50	6.15	3.75	3.10	2.80	3.95
19	2.70	2.60	2.50	4.70	3.25	3.45	5.75	3.60	3.00	2.80	3.85
20	2.70	2.60	2.55	13.30	3.30	2.95	4.70	3.55	3.00	2.80	3.55
21	2.70	2.55	3.00	6.65	8.00	3.00	5.05	3.45	3.00	2.80	3.45
22	2.70	2.55	2.90	4.95	15.00	2.90	4.85	3.40	3.00	2.80	3.35
23	2.70	2.50	2.65	4.55	.....	2.90	5.00	3.40	3.00	3.50	3.25
24	2.70	2.55	2.60	4.45	.....	2.85	5.25	3.30	3.00	3.20	3.25
25	2.65	2.75	2.85	4.25	.....	2.80	4.45	3.30	3.00	2.95	3.45
26	2.55	2.70	5.20	4.05	.....	2.80	5.05	3.25	3.00	2.80	3.55
27	2.65	2.60	5.00	3.75	.....	2.80	4.60	3.15	3.00	2.80	3.60
28	2.60	2.55	3.70	3.70	.....	2.80	5.00	4.40	3.00	2.80	3.70
29	2.65	.....	3.20	3.60	.....	2.90	4.80	5.50	3.00	2.80	8.70
30	2.60	.....	3.40	3.55	.....	2.90	4.55	4.20	3.00	2.75	6.20
31	2.60	.....	3.45	.....	.....	2.90	5.00	.....	3.00	.....	4.80

NEW RIVER, NEAR OLDTOWN, VA.

This station was established July 31, 1900, and is described in Water-Supply Paper No. 48, page 181. A measurement of discharge was made on June 29, 1901, by N. C. Curtis, when the gage height was 2.85 feet and the discharge 6,916 second-feet.

Daily gage height, in feet, of New River at Oldtown, Va., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	6.40	6.50	6.40	5.70	5.07	5.10	4.10	6.10	3.20	5.20	6.50	6.50
2	6.50	6.60	6.50	4.80	5.90	5.03	5.10	6.20	4.20	4.20	6.50	6.50
3	6.60	6.70	6.60	.....	5.90	5.40	5.40	6.40	4.70	5.00	6.50	6.20
4	6.60	6.30	6.50	3.50	5.80	5.50	5.40	6.40	4.90	5.40	6.40	5.80
5	6.70	6.20	6.60	4.70	6.10	5.60	5.40	6.40	5.10	5.60	6.40	5.80
6	6.70	6.50	6.60	5.20	6.10	5.70	5.50	([a])	5.20	5.80	6.40	6.30
7	6.60	6.50	6.70	5.30	6.10	4.80	5.30	2.40	5.30	5.80	6.50	6.40
8	6.60	6.40	6.70	5.60	5.90	5.10	5.40	4.40	5.40	5.80	6.50	6.50
9	6.50	6.30	6.80	5.70	5.80	5.60	5.70	5.30	5.40	5.90	6.50	6.50
10	6.50	5.30	6.40	5.90	5.70	5.70	5.80	5.60	5.60	6.00	6.60	5.80
11	6.30	5.40	5.90	6.00	5.70	6.70	5.80	5.50	5.60	6.00	6.60	5.10
12	4.30	6.30	6.00	6.10	5.80	5.80	5.90	5.40	5.70	6.10	6.60	6.20
13	4.90	6.40	6.30	6.20	6.10	5.90	5.10	.....	5.70	4.90	6.60	6.30
14	5.50	6.60	6.40	5.40	6.20	4.90	4.70	.....	5.80	4.00	6.70	5.30
15	5.90	6.50	6.50	5.50	6.20	.....	5.90	.....	5.80	5.40	6.70	([a])
16	6.20	6.50	6.50	5.80	6.30	.....	5.70	.....	5.70	5.70	6.70	3.20
17	6.20	6.50	6.60	5.90	5.80	.....	5.70	.....	5.40	5.90	6.70	4.30
18	6.40	6.50	6.60	6.10	6.10	3.80	4.90	.....	5.30	6.10	6.80	5.40
19	6.50	6.60	6.70	6.10	5.70	4.40	4.10	3.20	5.40	6.20	6.80	5.60
20	6.60	6.60	6.60	.....	5.90	4.90	4.40	3.70	5.60	6.10	6.80	5.80
21	6.30	6.70	6.20	.....	5.10	4.30	5.90	3.40	5.80	6.20	6.90	5.70
22	6.30	6.70	6.30	3.60	([a])	3.50	5.10	4.20	5.90	6.30	6.90	5.80
23	6.40	6.60	6.50	4.50	.....	.....	6.10	.....	5.90	6.30	5.90	5.90
24	6.40	([b])	6.60	4.70	3.40	.....	6.20	3.50	6.10	6.30	5.90	4.80
25	6.50	([b])	6.30	4.90	4.20	4.30	6.30	4.30	6.20	6.30	6.10	4.10
26	6.50	([b])	.....	4.70	4.60	4.50	6.30	4.50	6.20	6.40	6.20	5.30
27	6.60	([b])	4.30	5.10	2.90	4.70	6.20	4.20	5.10	6.40	6.30	5.60
28	6.60	6.20	5.40	5.20	3.40	4.10	6.10	.....	5.30	6.40	6.30	5.40
29	6.70	.....	5.80	5.30	3.10	4.80	6.30	3.60	2.20	6.40	6.40	([a])
30	6.60	.....	5.30	5.50	4.60	5.20	6.30	4.30	4.50	6.50	6.60	1.30
31	6.50	.....	5.30	.....	4.90	.....	6.40	4.20	.....	6.50	.....	3.50

[a] Water over gage. [b] Frozen.

NEW RIVER AT RADFORD, VA.

This station, which was established by D. C. Humphreys on August 1, 1898, the gage having been erected by the United States Weather Bureau, is described in Water-Supply Paper No. 48, page 178. During 1901 the following measurements were made by D. C. Humphreys:

July 20: Gage height, 2.15 feet; discharge, 8,245 second-feet.
March 29: Gage height, 2 feet; discharge, 10,103 second-feet.
August 8: Gage height, 4.01 feet; discharge, 19,213 second-feet.

Daily gage height, in feet, of New River at Radford, Va., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	0.80	0.50	0.40	1.70	1.70	3.40	3.90	1.10	3.60	3.90	0.30	0.20
2	.70	.40	.30	2.00	1.50	2.90	3.60	1.10	3.40	2.50	.30	.10
3	.80	.60	.30	11.17	1.50	2.50	2.80	1.00	3.00	1.90	.30	.30
4	.70	.70	.20	6.60	1.40	1.90	2.20	.90	3.00	1.50	.40	1.40
5	.60	1.00	.20	3.00	1.30	1.70	2.30	1.00	2.60	1.10	.40	1.20
6	.50	.90	.00	2.20	1.20	1.50	2.10	12.10	2.20	1.00	.30	.90
7	.40	.80	.30	2.00	1.20	1.90	2.30	12.00	1.90	.90	.30	.60
8	.50	.70	— .60	1.60	1.20	3.00	2.30	5.09	1.80	.90	.30	.50
9	.40	1.00	— .50	1.50	1.30	1.90	2.60	4.30	1.60	.90	.30	.40
10	.40	1.30	.50	1.20	1.90	1.70	1.60	2.10	1.50	.90	.30	.40
11	.60	1.50	+1.90	1.10	2.70	1.50	1.50	3.20	1.50	.80	.20	.30
12	4.30	1.30	1.80	1.00	2.00	1.40	1.40	4.00	1.50	.80	.20	.40
13	3.00	1.00	1.20	1.00	1.70	1.50	1.30	5.30	1.40	.90	.20	.40
14	2.10	.80	.80	.90	1.30	2.45	4.60	7.50	1.40	3.00	.20	.70
15	1.70	.80	.80	3.00	1.20	5.90	3.50	6.00	1.40	1.60	.20	19.50
16	1.40	.80	.70	2.00	1.00	5.00	2.30	4.85	1.50	1.40	.10	7.50
17	1.10	.70	.60	1.60	1.10	6.40	2.00	3.30	1.80	1.20	.10	4.00
18	1.00	.70	.50	1.40	1.20	4.80	2.30	6.70	1.50	1.00	.10	3.00
19	.70	.70	.50	1.20	1.90	3.50	3.00	4.50	1.40	.90	.10	2.00
20	.40	.60	.50	18.45	1.70	2.80	2.30	3.40	1.40	.90	.00	1.50
21	.70	.60	.50	11.30	1.75	2.90	2.20	3.00	1.20	.80	.00	1.10
22	1.10	.50	1.00	5.20	22.90	2.70	1.90	3.50	1.20	.80	.00	1.00
23	.90	.40	.80	4.50	12.20	8.40	1.30	6.70	1.00	.60	.00	.90
24	.80	.20	.70	3.20	6.00	4.90	1.20	5.00	1.00	.60	1.20	.80
25	.70	.10	.60	2.90	3.80	4.00	1.10	3.50	1.00	.50	1.00	1.80
26	.60	.60	1.95	2.70	5.30	3.10	1.10	3.10	1.00	.50	.80	1.50
27	.60	.60	5.00	2.50	6.50	3.00	1.00	3.00	.90	.50	.70	1.50
28	.60	.50	3.50	2.30	6.70	2.40	1.00	7.70	.90	.50	.50	2.00
29	.80	.....	2.10	2.00	5.50	2.70	1.00	7.00	5.25	.40	.40	16.25
30	.70	.....	1.50	1.90	4.30	2.90	1.00	4.00	3.60	.40	.20	16.00
31	.70	.....	1.70	.....	3.60	.....	1.00	3.60	.....	.40	.....	10.00

NEW RIVER AT FAYETTE, W. VA.

This station, which was established July 29, 1895, is just above the mouth of Wolf Creek, on the one-span highway bridge at Fayette, W. Va. It is described in Water-Supply Paper No. 48, page 181. Results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 222. The station was discontinued May 22, 1901. During 1901 the following measurements were made by D. C. Humphreys:

March 27: Gage height, 7.54 feet; discharge, 16,813 second-feet.
July 30: Gage height, 3.55 feet; discharge, 6,706 second-feet.

Daily gage height, in feet, of New River at Fayette, W. Va., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	Day.	Jan.	Feb.	Mar.	Apr.	May.
1	3.70	4.90	4.80	8.90	9.00	17	6.70	3.80	4.70	19.00	6.40
2	3.40	4.60	5.30	11.10	8.60	18	5.80	3.70	4.10	21.40	5.70
3	3.50	4.40	5.50	14.50	7.80	19	5.00	3.50	3.80	25.30	6.00
4	3.70	4.30	5.60	20.90	[a]7.10	20	4.00	3.20	3.50	26.80	6.80
5	3.90	4.00	5.40	16.20	6.40	21	3.40	3.00	3.40	[a]33.10	7.90
6	3.70	3.70	5.30	15.40	6.00	22	3.10	3.10	3.10	25.50	20.65
7	3.60	3.90	5.10	14.20	5.70	23	3.00	3.20	3.00	20.70	.....
8	4.90	4.40	5.00	12.50	6.20	24	3.00	3.40	3.30	17.40	.....
9	6.30	5.00	5.30	11.80	7.10	25	3.50	3.50	4.30	15.60	.....
10	9.00	5.30	5.80	10.00	8.50	26	3.80	3.80	5.00	13.80	.....
11	9.60	5.80	7.00	9.20	9.00	27	4.30	4.00	9.20	14.50	.....
12	12.00	6.20	12.00	7.40	9.60	28	5.00	4.40	9.00	12.80	.....
13	11.10	5.80	13.10	7.20	9.00	29	5.25	.....	8.70	11.40	.....
14	9.40	5.60	11.20	7.40	8.30	30	5.60	.....	8.10	10.50	.....
15	8.30	5.20	8.40	13.50	7.50	31	5.20	.....	7.40	.....	.....
16	7.50	4.00	5.00	14.70	7.20						

[a] Estimated.

OLENTANGY RIVER AT COLUMBUS, OHIO.

This station was established November 22, 1898, at the Fifth avenue bridge, Columbus. It is described in Water-Supply Paper No. 49, page 218. During 1901 the observations at this point were made under the general direction of Prof. C. N. Brown, of the Ohio State University. Results of measurements will be found in the Twenty-second Annual Report, Part IV, page 237.

Daily gage height, in feet, of Olentangy River at Columbus, Ohio, for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.20	1.40	2.00	2.00	1.30	2.30	1.70	1.00	.90	.90	.80	1.00
2	1.20	1.40	2.10	2.00	1.30	2.20	1.70	1.00	1.00	.90	.80	.90
3	1.20	1.40	2.20	2.00	1.30	1.80	1.70	1.00	1.30	.90	.80	.90
4	1.20	1.50	2.95	2.00	1.30	1.80	1.70	1.00	1.20	1.10	.90	.90
5	1.20	2.00	2.95	1.65	1.30	1.80	6.55	1.00	1.20	1.00	.90	.90
6	1.40	2.75	3.00	1.50	1.30	1.80	3.60	1.00	1.15	1.00	.90	.90
7	1.40	2.90	3.00	1.40	1.30	1.70	2.45	1.00	1.10	1.00	.90	.90
8	1.40	2.90	2.45	1.40	1.30	1.70	2.00	1.00	1.10	1.00	.85	1.00
9	1.40	2.90	3.50	1.40	1.30	1.70	1.70	.95	1.05	1.00	.80	1.05
10	1.40	2.90	5.60	1.40	1.30	1.70	1.70	.90	.90	.90	.80	1.20
11	2.50	2.90	5.25	1.40	1.30	1.70	1.55	.90	.90	.90	.80	1.20
12	3.00	2.90	4.15	1.40	1.30	1.70	1.20	.90	1.00	.90	.80	1.20
13	3.00	2.70	3.10	1.40	1.20	1.70	1.20	.90	.95	.90	.80	1.35
14	2.30	2.50	3.00	1.40	1.20	1.70	1.20	.90	.90	.90	.80	1.95
15	2.05	2.50	2.70	1.20	1.20	1.80	1.15	.90	.90	.90	.80	3.40
16	1.80	2.50	2.50	1.20	1.20	4.30	1.10	.90	.80	.90	.80	2.65
17	1.80	2.50	2.50	1.20	1.20	3.80	1.10	.90	.90	.90	.90	2.30
18	1.80	2.50	2.25	1.20	1.20	3.05	1.10	.90	1.00	.90	.90	2.10
19	1.50	2.50	2.20	1.20	1.10	2.80	1.10	.95	1.00	.90	.90	2.10
20	1.50	2.50	2.20	1.20	1.10	2.65	1.10	.95	1.00	.90	.90	2.10
21	1.50	2.50	2.50	1.40	1.30	2.40	1.00	.90	.90	.80	.90	2.10
22	1.40	2.50	2.45	1.55	3.00	3.20	1.00	.90	.90	.80	.90	2.40
23	1.40	2.50	2.20	2.15	3.20	2.90	1.00	.90	.90	.80	.90	2.30
24	1.40	2.50	2.10	2.40	2.60	2.40	1.00	.90	.90	.80	.90	2.20
25	1.40	2.50	2.15	2.05	1.95	5.40	1.00	.90	.90	.80	.90	2.20
26	1.40	2.20	3.10	1.90	1.70	4.95	1.00	.90	.85	.80	.90	2.20
27	1.40	2.20	3.25	1.70	1.70	2.80	1.00	.90	.80	.80	.90	2.20
28	1.40	2.00	2.85	1.50	2.05	2.35	1.00	.85	.80	.80	.90	2.20
29	1.40	.....	2.25	1.30	3.70	2.20	1.00	.70	.90	.80	.90	2.20
30	1.40	.....	2.00	1.30	3.15	1.75	1.00	.70	.90	.80	.90	2.20
31	1.40	.....	2.00	.....	2.65	.....	1.00	.70	.....	.80	.....	2.20

SCIOTO RIVER AT COLUMBUS, OHIO.

This station was established November 22, 1898, at Grandview avenue bridge, Columbus. It is described in Water-Supply Paper No. 49, page 219. During 1901 the observations were made under the general direction of Prof. C. N. Brown, of the Ohio State University. Results of measurement for the year 1900 will be found in the Twenty-second Annual Report, Part IV, page 236.

Daily gage height, in feet, of Scioto River at Columbus, Ohio, for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	9.40	10.10	9.50	10.90	10.20	12.15	10.35	9.25	9.00	8.80	8.75	8.90
2	9.30	9.90	9.70	10.65	10.15	11.55	10.15	9.20	8.95	8.80	8.90	8.95
3	9.30	9.75	10.65	10.55	10.00	11.15	10.00	9.20	8.75	8.90	8.80	9.00
4	9.25	10.20	11.95	10.45	9.90	10.90	10.75	9.20	8.70	8.90	8.70	9.00
5	9.20	10.85	12.10	10.40	9.90	10.70	15.40	9.20	8.70	8.85	8.70	9.00
6	9.20	10.95	11.45	10.30	9.90	10.65	12.65	9.20	8.70	8.80	8.70	9.00
7	9.20	11.20	11.50	10.30	9.80	10.45	12.25	9.20	8.80	8.75	8.70	9.00
8	9.25	11.15	11.25	10.20	9.80	10.35	12.25	9.20	8.80	8.70	8.70	9.00
9	9.30	10.85	13.50	10.20	9.90	10.20	11.45	9.20	8.75	8.70	8.80	9.00
10	9.45	10.40	15.55	10.10	10.05	10.05	10.80	9.20	8.65	8.70	8.80	9.15
11	11.65	10.60	16.05	10.05	10.50	10.00	10.40	8.70	8.60	8.70	8.80	9.20
12	12.40	10.30	15.00	9.95	10.65	9.85	10.15	8.70	8.70	8.70	8.80	9.10
13	11.70	10.25	14.60	9.85	10.35	9.80	10.05	8.70	8.70	8.70	8.80	9.15
14	11.35	10.25	14.35	9.90	10.15	9.80	9.95	8.65	8.70	8.70	9.05	9.30
15	11.15	10.15	13.80	9.90	9.95	10.10	9.80	8.60	8.70	8.70	9.15	9.45
16	10.90	10.60	13.25	9.90	9.85	10.80	9.80	8.60	8.70	8.70	8.75	9.60
17	10.85	9.95	12.65	9.80	9.80	12.20	9.90	8.70	8.75	8.70	8.60	9.85
18	10.50	9.80	12.20	9.80	9.70	11.55	10.60	8.70	8.90	8.70	8.75	10.00
19	10.15	9.80	11.90	9.85	9.70	11.00	11.15	8.70	8.90	8.70	9.10	9.80
20	10.05	9.90	11.70	9.90	9.60	10.65	9.90	8.70	8.85	8.70	9.20	9.75
21	10.35	9.85	11.70	10.00	10.10	10.60	9.75	8.70	8.80	8.70	8.95	9.60
22	10.20	9.90	11.45	10.55	12.20	11.40	9.65	8.70	8.80	8.70	8.90	9.55
23	10.15	9.85	11.30	11.10	11.80	12.55	9.55	8.70	8.75	8.70	9.00	9.45
24	10.10	9.75	11.15	11.30	11.40	11.65	9.50	8.70	8.65	8.70	9.00	9.40
25	9.95	9.85	11.25	11.25	11.15	12.35	9.40	8.70	8.60	8.70	9.00	9.40
26	9.70	9.85	13.45	11.05	10.95	12.90	9.40	8.70	8.60	8.70	9.05	9.30
27	9.80	9.85	13.55	10.90	10.65	12.30	9.40	8.70	8.60	8.70	9.10	9.30
28	9.85	9.75	12.75	10.75	10.75	11.45	9.40	8.80	8.60	8.70	9.05	9.30
29	9.80	.....	12.00	10.55	12.20	11.00	9.40	8.85	8.65	8.70	9.00	9.25
30	9.85	.....	11.45	10.35	12.60	10.60	9.30	8.90	8.80	8.70	8.95	9.20
31	10.00	.....	11.15	.....	12.65	.....	9.30	8.90	.....	8.70	.....	9.20

CUMBERLAND RIVER AT NASHVILLE, TENN.

The gage, which belongs to the United States Engineer Corps, is at the foot of Broad street. It is in three sections, two of which are upright and one inclined. The lowest section, extending from −0.2 foot to +46 feet, is on the slope of the bank and consists of timbers bedded in the ground, bearing an iron strap, into which the markings are cut. The section extending from gage height 46 to 53 feet is fastened to a small building at top of bank and consists of a timber painted white with black markings. The top section of the gage, extending from 52 feet to 55.3 feet, is on the corner of Temperance Hall, painted on the stones in white with black markings. In addition there is a vertical section reading from −1.2 feet to +2 feet. The datum of the gage corresponds to elevation 110.3 feet of the city levels. A crosscut on upper face of corner stone in southeast corner of Temperance Hall, on Broad street, near Front street, is 52 feet above the zero of the gage and 366.6 feet above mean sea level. Another bench mark is the top of rail in station of Nashville, Chattanooga and St. Louis Railroad, the elevation of which is 120.2 feet above the zero of the gage and 434.8 feet above mean sea level. The highest observed water was 55.3 feet on January 22, 1882. The lowest occurred on October 15 and 16, 1878, at a gage height of −0.4 foot. The danger line is at 40 feet.

Records have been kept for a number of years by the United States Weather Bureau, from whom readings previous to those here pub-

lished may be obtained. The following measurements were made at this station during 1901 by Max Hall:

February 7: Gage height, 18.95 feet; discharge, 39,161 second-feet.
April 20: Gage height, 26 feet; discharge, 66,408 second feet.
September 10: Gage height, 4.20 feet; discharge, 5,470 second-feet.

Daily gage height, in feet, of Cumberland River at Nashville, Tenn., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	9.70	10.10	4.60	13.30	19.50	10.00	5.80	1.40	9.90	4.10	1.60	2.10
2	9.50	10.20	4.50	20.00	15.60	8.90	5.30	1.60	9.00	4.10	1.60	2.10
3	9.30	11.70	4.40	24.10	13.20	9.20	5.20	1.40	7.90	3.80	1.60	2.20
4	9.50	18.40	4.30	26.00	11.10	8.60	4.60	1.30	6.80	3.70	1.60	2.30
5	9.90	19.50	4.10	28.80	9.50	7.50	4.10	1.30	6.00	3.50	1.60	2.40
6	9.50	19.60	4.10	29.50	8.60	6.50	3.80	1.40	5.40	3.60	1.70	2.30
7	8.70	19.30	4.10	30.00	7.90	8.10	3.40	1.60	5.00	3.70	1.80	2.20
8	8.50	18.50	4.10	26.50	7.20	7.70	3.20	1.60	4.90	3.40	1.70	2.20
9	7.30	17.80	4.40	24.40	6.70	6.80	3.00	1.70	4.90	3.20	1.70	2.20
10	6.70	15.60	4.80	19.00	6.40	6.00	3.30	2.00	4.40	3.00	1.70	2.10
11	8.20	13.80	10.50	15.40	6.50	5.60	3.20	2.10	3.80	2.80	1.70	3.20
12	14.40	12.30	13.60	13.90	6.00	5.70	3.20	1.80	3.70	2.70	1.70	3.00
13	18.40	11.20	15.40	10.40	5.80	6.00	3.10	4.00	3.50	2.80	1.60	3.00
14	22.40	10.30	15.50	11.40	5.60	5.80	3.10	8.40	3.20	2.70	1.60	7.70
15	25.80	9.60	16.00	11.50	5.50	5.70	3.10	12.20	4.40	3.10	1.70	15.20
16	27.40	9.10	15.90	12.10	5.30	5.40	2.90	14.90	3.90	3.10	1.70	17.10
17	26.80	8.70	14.40	12.70	5.00	4.80	2.70	24.30	6.00	3.20	1.70	23.10
18	24.70	8.30	12.20	13.10	4.80	4.40	2.60	30.90	11.90	3.00	1.70	27.30
19	18.90	8.00	10.30	16.50	5.30	4.30	2.80	35.70	15.80	2.80	1.70	28.90
20	14.40	7.60	9.00	26.30	8.60	4.80	2.90	38.00	20.40	2.60	1.70	28.50
21	11.30	7.00	8.00	29.50	11.00	6.70	2.50	39.60	23.20	2.40	1.70	27.50
22	9.50	6.70	7.40	33.40	14.30	7.50	2.30	39.30	23.00	2.20	1.70	19.00
23	8.40	6.40	7.00	36.30	15.30	7.30	2.10	37.30	19.50	2.20	1.70	13.00
24	9.00	6.00	7.20	37.50	17.10	7.90	1.90	35.30	14.60	2.10	1.70	9.60
25	9.50	5.70	7.60	37.80	21.60	13.20	1.70	29.50	10.40	2.00	1.70	10.49
26	8.70	5.30	8.00	37.40	23.10	17.20	1.60	24.30	8.20	2.00	1.70	12.00
27	8.40	5.00	8.50	35.80	22.70	16.00	1.50	19.90	6.70	1.90	1.70	13.80
28	8.90	4.80	8.20	32.50	19.70	12.20	1.40	16.20	5.80	1.80	1.80	13.90
29	8.70	.....	7.80	26.70	15.90	8.80	1.40	14.00	5.20	1.70	1.80	16.40
30	8.50	.....	8.00	21.90	12.80	6.90	1.40	12.00	4.80	1.70	2.00	21.80
31	9.80	.....	11.00	.....	10.80	.....	1.50	10.50	.....	1.60	.....	24.80

SOUTH FORK OF HOLSTON RIVER AT BLUFF CITY, TENN.

This station was originally established by the United States Weather Bureau at the highway bridge at Bluff City. Ratings were begun by the United States Geological Survey in July, 1900, and the station is described in Water-Supply Paper No. 48, page 180. The following measurements were made during 1901 by E. W. Myers and R. E. Shuford:

List of discharge measurements of South Fork Holston River at Bluff City, Tenn.

Date.	Hydrographer.	Gage height.	Discharge.
1901.		*Feet.*	*Sec.-ft.*
January 15	E. W. Myers	2.40	2,202
March 30	R. E. Shuford	2.50	2,900
April 15	E. W. Myers	2.00	1,548
April 21	R. E. Shuford	6.50	12,186
June 17	E. W. Myers	4.90	5,415
August 2	do	1.10	837
October 16	do	.90	628
October 19	do	.80	458
October 26	do	.65	361

Daily gage height, in feet, of South Fork of Holston River at Bluff City, Tenn., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.60	1.70	0.80	3.00	2.50	4.20	3.00	2.40	4.00	1.80	1.70	0.70
2	.80	1.60	.70	4.00	2.40	4.00	2.80	1.80	3.00	2.90	1.70	1.00
3	.80	1.60	.70	6.50	2.30	2.60	2.30	1.00	2.80	2.80	1.70	.80
4	.80	2.00	.70	5.30	2.20	2.50	2.00	1.00	2.70	2.80	.80	1.20
5	.80	3.00	1.60	3.70	2.30	2.50	1.80	3.00	2.40	2.60	.80	1.10
6	.80	2.80	1.60	3.00	2.30	2.40	1.80	5.00	2.20	1.90	.80	1.10
7	.80	2.70	1.50	3.20	2.30	4.80	2.80	4.80	2.00	1.60	.80	1.00
8	.70	2.00	1.40	2.10	2.20	4.00	3.66	3.20	1.80	1.20	.80	.90
9	.70	2.80	1.40	2.80	2.20	2.60	2.20	2.00	1.80	1.10	.80	.80
10	.80	3.20	1.60	2.50	2.40	2.50	1.10	1.80	1.80	1.10	.80	.80
11	4.00	3.00	1.80	2.20	2.70	2.30	1.10	1.60	1.80	1.16	.80	.80
12	6.60	2.60	1.60	2.10	2.70	2.10	1.10	1.00	1.70	1.10	.80	.80
13	4.80	2.40	1.40	2.20	2.60	2.00	1.10	4.00	1.70	1.80	.70	.80
14	3.80	2.00	1.60	2.20	2.40	2.00	1.10	5.00	1.80	1.80	.70	2.60
15	2.60	1.70	1.40	2.20	2.30	2.00	1.10	6.00	1.80	1.70	.70	6.00
16	2.20	1.60	1.20	2.00	2.20	2.00	1.10	5.00	1.80	1.70	.60	5.00
17	2.00	1.60	1.20	2.00	2.10	5.00	2.80	3.80	2.20	1.60	.60	4.10
18	1.90	1.60	1.10	1.80	2.00	4.00	2.60	3.60	2.10	1.40	.60	3.80
19	1.80	1.50	1.10	1.80	3.00	3.00	1.30	3.80	1.80	1.00	.50	3.00
20	1.80	1.50	1.10	9.40	3.80	2.80	1.30	3.70	1.80	.80	.50	2.40
21	1.20	1.40	1.10	8.00	9.00	2.70	1.10	4.00	1.80	.80	.40	2.00
22	1.80	1.40	1.00	7.70	15.00	3.00	1.60	3.80	1.80	.80	.40	2.00
23	1.70	1.30	1.00	7.00	6.00	8.90	1.40	3.40	1.80	.80	.40	2.10
24	1.70	1.30	1.60	6.80	5.00	5.20	1.10	2.80	1.80	.80	.70	2.00
25	1.60	1.20	2.00	5.00	3.50	4.00	1.00	3.00	1.80	.80	1.00	1.60
26	1.20	1.20	3.00	4.80	3.10	2.80	1.00	4.00	1.80	.80	.80	2.00
27	1.20	1.20	3.90	4.60	5.00	3.00	1.00	3.60	1.80	1.80	.80	6.70
28	1.30	1.00	4.00	4.00	5.30	3.20	1.00	3.00	1.80	1.80	.70	5.00
29	1.40	.....	5.00	4.00	5.60	3.00	1.00	2.80	1.90	1.80	.70	12.55
30	1.60	.....	3.80	2.60	5.40	2.80	1.00	2.00	1.90	1.70	.70	9.80
31	1.80	.....	2.80	.....	4.60	.....	1.00	3.00	.....	1.70	.....	5.40

WATAUGA RIVER AT BUTLER, TENN.

This station was established August 14, 1900, and is described in Water-Supply Paper No. 48, page 183. The bridge from which the measurements were made was carried away by flood in May, 1901, and has not been rebuilt. The following measurements were made during 1901 by E. W. Myers:

January 17: Gage height, 2.10 feet; discharge, 574 second-feet.
April 12: Gage height, 2.55 feet; discharge, 849 second-feet.

Daily gage height, in feet, of Watauga River, at Butler, Tenn., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.00	1.60	1.50	3.00	3.00	3.00	6.40	2.00	3.50	2.80	2.60	2.60
2	2.00	1.60	1.50	8.00	3.00	3.00	4.10	2.00	3.10	2.80	2.60	2.60
3	2.00	1.60	1.50	7.00	3.00	3.00	3.50	2.00	2.70	2.80	2.60	2.60
4	1.80	2.80	1.50	6.30	3.00	3.00	2.80	2.00	2.70	2.80	3.50	2.60
5	1.60	2.00	1.50	5.00	3.00	3.00	2.50	2.00	2.70	2.80	3.10	2.60
6	1.50	2.00	1.50	4.50	3.00	3.00	2.50	8.00	2.70	2.80	3.00	2.60
7	1.50	1.80	1.70	3.40	3.60	3.00	2.50	5.10	2.70	2.70	2.80	2.60
8	1.50	1.60	2.00	3.00	4.60	11.00	2.30	3.40	2.70	2.70	2.80	2.60
9	1.50	3.50	2.00	2.50	3.50	6.30	2.00	2.80	2.70	2.60	2.80	2.60
10	1.90	3.00	2.00	2.50	3.20	4.50	2.00	2.50	2.70	2.60	2.80	4.70
11	2.00	2.80	4.00	2.50	.....	4.50	2.00	3.50	2.70	2.60	2.80	3.60
12	7.00	2.80	3.00	2.50	3.20	3.60	2.00	7.60	3.00	2.60	2.80	3.10
13	5.00	2.40	2.00	2.50	2.80	3.40	2.00	5.30	3.00	4.10	2.80	3.00
14	4.30	2.00	2.00	2.50	2.60	3.00	2.00	4.50	2.70	4.00	2.80	9.50
15	3.60	2.00	2.00	2.50	2.60	3.00	2.00	4.70	2.70	3.60	2.80	8.00
16	3.00	2.00	2.00	2.50	2.60	3.00	2.00	6.70	4.50	3.60	2.80	6.00
17	2.60	2.00	2.00	2.50	2.60	2.50	2.00	6.70	3.60	3.20	2.80	4.50
18	2.60	1.80	2.00	2.50	2.60	2.50	2.00	5.90	3.10	3.20	2.80	3.69
19	2.60	1.60	1.80	2.50	2.80	2.50	2.00	4.60	3.00	3.20	2.80	3.00
20	2.10	1.00	1.60	12.00	3.00	2.50	2.00	4.00	3.00	3.20	2.80	3.00
21	2.00	.80	1.60	5.20	16.27	2.50	2.00	6.90	3.00	3.20	2.80	3.00
22	1.80	.80	1.60	4.50	11.00	2.50	2.00	5.80	3.00	3.20	2.80	3.00
23	1.60	.60	1.60	4.50	5.00	2.50	2.00	4.00	3.00	2.90	2.80	3.00
24	1.60	.60	1.80	4.50	4.60	2.50	2.00	3.50	3.80	2.90	2.60	6.00
25	1.60	.80	2.00	3.70	4.50	2.50	2.00	3.50	3.50	2.90	2.60	4.00
26	1.60	1.00	7.00	3.70	3.60	3.20	2.00	3.50	3.00	2.90	2.60	3.00
27	1.60	1.50	6.00	3.70	3.40	8.70	2.00	3.50	3.00	2.60	2.60	3.00
28	1.60	1.50	4.80	3.00	3.40	4.90	2.00	3.50	3.00	2.60	2.60	3.00
29	1.60	.....	3.50	3.00	3.40	3.80	2.00	3.50	3.00	2.60	2.60	.....
30	1.60	.....	3.00	3.00	3.40	2.60	2.00	3.50	2.80	2.60	2.60	.....
31	1.60	.....	3.00	.....	3.00	.....	2.00	3.50	.....	2.60	.....	.....

ROAN CREEK AT BUTLER, TENN.

This station was established on August 8, 1900, and is described in Water-Supply Paper No. 48, page 184. A record of the gage heights was kept during the year 1901, but owing to the floods the gage was carried away several times. In May, 1901, the bridge from which the measurements were made was carried away and has not been rebuilt. During the year the following measurements were made by E. W. Myers:

January 17: Gage height, 1.72 feet; discharge, 279 second-feet.
April 12: Gage height, 1.70 feet; discharge, 286 feet.
October 25: Gage height, .95 foot; discharge, 118 second-feet.

Daily gage height, in feet, of Roan Creek at Butler, Tenn., for 1901.

Day.	Feb.	Mar.	Apr.	May.	Aug.	Sept.	Oct.	Nov.
1	1.60	1.20	1.90	1.80	.....	6.60	1.50	0.80
2	1.50	1.20	3.30	1.90	.....	4.10	1.50	.85
3	1.60	1.20	6.25	1.80	.....	3.00	1.50	.90
4	1.60	1.20	(a)	1.70	.....	2.20	1.40	.90
5	1.80	1.30	.....	1.70	2.80	1.90	1.40	.80
6	1.90	1.30	.....	1.50	3.90	1.60	1.20	.80
7	2.20	1.40	.....	1.40	3.30	1.60	1.10	.80
8	2.00	1.30	.....	1.40	3.00	1.60	1.10	.80
9	1.80	1.20	.....	1.60	1.80	1.60	1.10	.75
10	1.80	1.20	.....	1.60	1.50	1.50	1.00	.80
11	1.40	1.30	.....	1.60	2.00	1.40	1.00	.80
12	1.60	1.25	1.20	1.60	3.05	1.45	1.20	.80
13	1.60	1.30	1.60	1.90	5.00	1.35	1.90	.90
14	1.60	1.40	1.60	1.80	4.50	1.30	1.50	.90
15	1.50	1.70	1.60	1.80	4.00	1.30	1.40	.95
16	1.40	1.50	1.50	1.70	4.00	1.30	1.40	.90
17	1.40	1.50	1.50	1.60	3.40	1.60	1.20	.90
18	1.40	1.30	1.45	1.40	3.00	1.50	1.10	.90
19	1.40	1.30	1.40	1.40	2.60	1.30	1.10	.80
20	1.30	1.30	6.45	1.90	4.45	1.30	1.10	.80
21	1.30	1.30	3.60	7.60	4.40	1.20	1.00	.80
22	1.30	1.30	3.00	(a)	3.00	1.20	1.00	.80
23	1.30	1.40	2.80	.....	2.60	1.15	1.00	1.00
24	1.40	1.30	2.50	.....	2.50	1.10	1.00	.....
25	1.45	1.30	3.20	.....	1.80	1.10	.95	.....
26	1.30	3.35	3.30	.....	2.20	1.00	.90	.....
27	1.30	3.30	2.60	.....	2.80	1.00	.80	.....
28	1.25	3.00	2.30	.....	2.40	1.00	.80	.....
29	.....	2.80	2.00	.....	2.00	1.80	.85	.....
30	.....	2.40	1.80	.....	2.00	1.60	.80	.....
31	.....	2.10	.....	.....	2.00	.....	.80	.....

[a] Gage washed out.

ELK CREEK AT LINEBACK, TENN.

This station was established August 18, 1900, and is described in Water-Supply Paper No. 48, page 184. On October 25, 1901, a measurement was made by E. W. Myers, when the gage height was 2 feet and the discharge 59 second-feet.

Daily gage height, in feet, of Elk Creek at Lineback, Tenn., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4.20	4.00	4.00	4.50	4.50	5.30	4.50	2.30	3.10	2.80	1.80	1.90
2	4.20	4.00	3.90	5.00	4.50	5.20	4.40	2.40	3.20	2.50	1.80	1.90
3	4.10	4.50	4.50	7.30	4.40	5.20	4.30	2.40	2.10	2.40	1.80	2.00
4	4.00	4.30	4.30	6.50	4.40	5.10	4.20	2.60	2.10	2.40	1.80	2.30
5	4.00	4.20	4.20	5.50	4.40	5.00	4.00	2.80	2.20	2.30	1.80	2.00
6	4.00	4.20	4.20	5.00	4.30	5.00	3.90	5.90	2.20	2.30	1.90	1.90
7	3.90	4.50	4.20	5.00	4.30	4.90	3.90	4.00	2.20	2.30	1.90	1.90
8	4.00	4.40	4.60	5.60	4.20	4.80	3.80	3.90	2.70	2.30	1.90	.....
9	4.10	5.20	4.40	5.50	4.50	4.90	3.80	3.60	2.80	2.30	1.90	.....
10	6.00	4.40	4.40	4.50	4.40	4.10	3.70	3.70	2.90	2.20	1.90	.....
11	6.20	6.00	4.30	4.60	4.50	4.80	3.60	3.90	2.80	2.60	1.90	.....
12	5.40	5.20	4.20	4.70	4.40	5.00	3.50	6.30	2.80	2.40	1.90	.....
13	4.50	4.30	4.80	4.00	4.40	5.00	3.40	8.70	2.80	2.00	1.90	.....
14	4.30	4.20	5.60	4.20	4.30	5.00	3.40	8.00	2.90	2.00	1.80	.....
15	4.20	4.20	4.30	4.40	4.30	4.90	3.30	7.90	2.90	2.00	1.80	.....
16	4.10	4.20	4.20	4.40	4.30	4.90	3.20	8.80	2.70	2.00	1.80	.....
17	4.20	4.00	4.10	4.30	4.40	4.10	3.20	8.70	2.60	2.10	1.70	.....
18	4.30	4.60	4.10	4.30	4.50	4.10	3.10	8.70	2.60	2.10	1.70	.....
19	4.20	4.40	4.20	6.20	5.00	4.90	3.00	7.00	2.50	2.10	1.70	.....
20	4.00	4.30	4.20	7.30	5.60	4.90	3.00	6.00	2.40	2.00	1.80	.....
21	4.20	4.20	5.00	6.40	15.00	4.11	2.90	5.50	2.40	2.00	1.80	.....
22	4.20	4.10	4.30	6.00	8.00	8.20	2.70	5.40	2.40	2.00	1.80	.....
23	4.30	4.00	4.20	5.70	6.60	6.00	2.60	4.40	2.40	1.80	2.20	.....
24	4.20	3.90	4.20	5.50	5.10	5.10	2.40	4.00	2.30	1.90	1.90	.....
25	4.00	3.90	4.60	5.80	5.90	5.80	2.30	4.00	2.30	1.90	1.90	.....
26	4.00	4.00	7.20	5.70	6.40	5.40	2.30	3.90	2.30	1.90	1.80	.....
27	4.20	4.10	5.30	5.50	5.11	5.00	3.20	3.70	2.30	1.90	1.80	.....
28	4.10	4.00	5.00	5.00	5.60	5.20	2.20	3.50	4.00	1.90	1.80	.....
29	4.10	.....	4.70	4.70	5.60	5.20	2.30	3.40	3.40	1.80	1.80	.....
30	4.10	.....	4.50	4.60	5.40	5.10	2.30	3.20	3.20	1.80	1.80	.....
31	4.10	.....	4.50	.....	5.40	.....	2.30	3.10	.....	1.80	.....	.....

NOLICHUCKY RIVER NEAR CHUCKY VALLEY, TENN.

This station was established September 6, 1900, and is described in Water-Supply Paper No. 48, page 185. The bridge from which measurements were made was carried away by the flood of May, 1901, and has not been replaced, so that the record of gage heights stops on that date. The following measurements were made during 1901 by E. W. Myers and R. E. Shuford:

March 31: Gage height, 5.18 feet; discharge, 5,356 second-feet.
April 14: Gage height, 4.45 feet; discharge, 3,022 second-feet.

Daily gage height, in feet, of Nolichucky River at Chucky Valley, Tenn., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	Day.	Jan.	Feb.	Mar.	Apr.	May.
1	3.20	3.20	3.10	4.10	4.30	17	3.70	3.30	3.30	3.20	3.30
2	3.30	3.00	2.80	6.80	4.10	18	3.50	3.40	3.20	3.10	3.30
3	3.50	3.30	2.80	8.60	4.10	19	3.20	3.20	3.10	3.20	3.40
4	3.30	3.20	2.80	6.40	4.80	20	3.30	3.30	3.30	4.60	3.40
5	3.10	3.30	3.30	5.30	4.00	21	3.40	3.30	3.30	3.40	3.50
6	3.00	3.30	3.20	4.90	3.80	22	3.20	3.30	3.40	3.30	([a])
7	3.00	3.40	2.90	4.70	3.60	23	3.50	3.40	3.40	3.30	.....
8	3.20	3.40	3.00	4.60	3.60	24	3.30	3.20	3.20	3.40	.....
9	3.00	4.00	3.30	4.40	4.00	25	3.30	3.40	3.30	3.80	.....
10	2.90	4.20	3.30	4.20	3.80	26	3.20	3.30	8.00	4.40	.....
11	3.00	3.90	4.70	4.00	3.80	27	3.20	3.20	5.30	4.50	.....
12	3.60	3.80	3.80	3.80	3.70	28	3.30	3.20	5.30	4.40	.....
13	5.20	3.60	3.50	3.00	3.60	29	3.30	.....	4.50	4.50	.....
14	4.30	3.40	3.30	3.20	3.50	30	3.20	.....	4.60	4.40	.....
15	4.00	3.30	3.30	3.10	3.40	31	3.30	.....	4.40	.....	.....
16	3.90	3.40	3.40	3.20	3.40						

[a] Bridge and gage washed out.

FRENCH BROAD RIVER NEAR ASHEVILLE, N. C.

This station was established by C. C. Babb in September, 1895. It is located at the Bingham School iron highway bridge, 3 miles west of Asheville. It is described in Water-Supply Paper No. 48, page 186. Records of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 223. On October 14, 1901, the gage was changed to read 0.58 feet less than before. Gage heights for the remainder of the year were, however, reduced to agree with those preceding. During 1901 the following measurements were made by E. W. Myers, R. E. Shuford, and others:

List of discharge measurements of French Broad River near Asheville, N. C.

Date.	Hydrographer.	Gage height.	Discharge.
1901.		*Feet.*	*Sec. ft.*
February 28	R. E. Shuford	3.60	2,955
March 27	do	8.97	19,377
April 16	E. W. Myers	4.68	3,308
May 21	R. E. Shuford	12.10	31,100
July 4	do	4.06	2,942
July 31	E. W. Myers	3.60	1,769
August 6	R. E. Shuford	9.50	20,240
August 15	do	9.30	18,528
September 18	E. W. Myers	6.90	8,760
October 14	do	4.33	2,950
November 10	R. E. Shuford	3.30	1,857
December 10	do	3.45	1,996

Daily gage height, in feet, of French Broad River near Asheville, N. C., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4.10	3.65	3.43	4.50	4.45	4.80	4.63	3.55	7.00	4.10	3.56	3.28
2	3.90	3.60	3.40	6.85	4.40	4.55	(a)	3.47	6.40	5.80	3.56	3.28
3	3.85	3.65	3.40	8.15	4.30	4.45	.....	3.41	5.90	5.00	3.54	3.88
4	3.77	4.75	3.40	7.20	4.28	4.40	.....	3.60	5.61	4.61	3.53	3.98
5	3.73	3.95	3.38	5.65	4.23	4.57	.....	3.61	5.48	4.30	3.51	3.58
6	3.60	3.87	3.38	5.30	4.18	4.65	.....	8.75	5.20	4.10	3.49	3.52
7	3.61	3.80	3.38	5.00	4.02	5.27	.....	8.20	5.02	4.05	3.48	3.47
8	3.59	3.85	3.38	4.75	4.01	4.87	.....	6.90	4.97	4.00	3.45	3.38
9	3.55	3.95	3.37	4.60	4.15	4.42	.....	4.15	4.98	3.95	3.42	3.48
10	3.60	3.90	3.62	4.85	4.20	4.33	.....	4.23	4.93	3.94	3.40	3.48
11	4.49	3.85	5.20	4.60	4.17	4.25	.....	4.33	4.98	3.94	3.39	4.18
12	7.40	3.85	4.00	4.35	4.15	4.22	.....	4.60	4.80	3.90	3.58	3.83
13	6.33	3.82	3.75	4.25	4.10	4.20	.....	5.70	5.10	4.73	3.38	3.73
14	5.30	3.75	3.60	5.55	4.05	6.30	.....	8.27	4.85	4.20	3.28	5.48
15	4.40	3.68	3.53	4.92	3.95	6.81	.....	9.01	4.60	3.93	3.30	9.98
16	4.25	3.67	3.52	4.55	3.93	6.60	.....	8.77	4.42	3.88	3.31	9.08
17	4.10	3.64	3.49	4.50	3.91	5.75	.....	9.40	6.75	3.73	3.30	7.28
18	4.05	3.62	3.46	4.40	4.21	5.38	.....	8.60	6.80	3.67	3.30	5.08
19	4.00	3.60	3.44	7.40	4.67	4.90	.....	8.00	5.37	3.63	3.29	4.98
20	3.92	3.58	3.42	7.95	5.58	5.15	.....	7.70	4.95	3.62	3.29	4.39
21	3.87	3.55	4.60	7.40	8.65	5.67	.....	7.28	4.62	3.60	3.28	4.37
22	3.83	3.53	4.15	6.95	10.40	5.30	.....	7.08	4.45	3.59	3.28	4.38
23	3.80	3.50	3.80	6.65	6.35	4.85	.....	7.48	4.37	3.58	3.29	4.25
24	3.80	3.50	3.70	6.25	5.55	4.75	.....	7.55	4.30	3.58	3.35	4.13
25	3.77	3.50	5.45	5.95	5.83	4.70	.....	6.80	4.20	3.58	3.37	4.13
26	3.68	3.50	9.92	5.00	5.73	4.77	.....	6.35	4.10	3.58	3.36	4.15
27	3.67	3.48	8.43	4.88	5.57	4.53	.....	6.25	4.05	3.57	3.34	4.18
28	3.65	3.45	7.35	4.65	5.30	4.67	.....	6.77	4.00	3.57	3.32	4.58
29	3.54	.....	5.27	4.58	5.17	4.75	.....	8.55	4.65	3.56	3.30	10.95
30	3.70	.....	5.00	4.50	4.97	4.70	.....	8.48	4.28	3.56	3.29	9.48
31	3.73	.....	4.75	.....	4.85	.....	3.60	7.40	.....	3.56		9.13

[a] Wire broken.

FRENCH BROAD RIVER AT OLDTOWN, TENN.

This station was established September 4, 1900, and is described in Water-Supply Paper No. 48, page 187. During 1901 the following measurements were made by E. W. Myers:

January 15: Gage height, 1.70 feet; discharge, 2,936 second-feet.
March 29: Gage height, 4 feet; discharge, 14,397 second-feet.
August 1: Gage height, 1.54 feet; discharge, 2,475 second-feet.
August 18: Gage height, 6.60 feet; discharge, 29,824 second-feet.
September 27: Gage height, 1.83 feet; discharge, 2,954 second-feet.

Daily gage height, in feet, of French Broad River at Oldtown, Tenn., for 1901.

Day.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Oct.	Nov.
1	.....	1.30	2.60	2.20	2.50	2.40	1.70	.....	1.50
2	.....	1.40	7.60	2.10	2.40	2.30	1.60	.....	1.50
3	.....	1.30	7.30	2.00	2.20	2.20	1.60	.....	1.50
4	.....	1.40	5.60	.....	2.20	2.10	1.50	.....	1.60
5	.....	1.50	3.90	1.90	2.10	2.00	2.10	.....	1.70
6	.....	1.40	3.10	1.80	2.10	1.90	3.50	.....	1.70
7	.....	1.30	2.90	1.90	2.20	2.10	4.00	.....	1.60
8	.....	1.40	2.60	1.80	2.50	2.00	4.20	.....	1.60
9	.....	1.40	2.40	1.70	2.40	1.90	3.00	.....	1.60
10	.....	1.60	2.30	1.90	2.30	1.80	2.80	.....	.....
11	.....	2.20	2.20	1.80	2.20	1.70	2.00	.....	.....
12	.....	2.20	2.10	1.70	2.10	1.60	3.80	.....	.....
13	.....	1.80	2.00	1.60	2.00	1.50	4.00	2.00	.....
14	.....	1.60	2.60	1.60	2.70	1.50	6.70	1.90	.....
15	.....	1.60	2.60	1.60	3.40	1.60	6.70	1.80	.....
16	.....	1.60	2.40	1.50	3.90	1.70	6.50	1.70	.....
17	.....	1.40	2.20	1.50	3.40	1.80	7.00	1.70	.....
18	.....	1.40	2.10	2.10	2.80	2.90	6.00	1.60	.....
19	.....	1.50	2.00	2.50	2.50	2.10	5.00	1.60	.....
20	.....	1.40	5.40	3.00	2.80	2.20	4.50	1.70	.....
21	.....	1.50	3.10	10.50	2.70	2.10	4.40	1.60	.....
22	.....	2.00	3.50	9.30	2.80	2.00	4.30	1.60	.....
23	.....	1.70	3.80	6.00	2.50	1.90	4.50	1.60	.....
24	1.40	1.80	3.60	4.70	2.40	1.80	4.00	1.50	.....
25	1.30	2.00	3.50	3.50	2.50	1.70	3.80	1.50	.....
26	1.30	8.30	4.00	3.40	2.20	1.60	3.50	1.50	.....
27	1.30	6.30	5.00	3.80	2.00	1.50	4.00	1.60	.....
28	1.30	5.90	2.00	3.50	2.10	1.50	4.10	1.60	.....
29	.....	3.70	2.40	3.10	2.20	1.60	4.00	1.60	.....
30	.....	2.90	2.30	2.80	2.20	1.60	4.10	1.50	.....
31	.....	3.00	.....	2.60	.....	1.70	4.20	1.50	.....

PIGEON RIVER AT NEWPORT, TENN.

This station was established September 4, 1900, and is described in Water-Supply Paper No. 48, page 188. The gage was washed out several times during the year by high waters. During 1901 the following measurements were made by E. W. Myers and R. E. Shuford:

January 19: Gage height, 1.95 feet; discharge, 1,188 second-feet.
March 29: Gage height, 2.91 feet; discharge, 4,355 second-feet.
August 1: Gage height, 1.07 feet; discharge, 648 second-feet.
August 18: Gage height, 6 feet; discharge, 7,624 second-feet.
September 27: Gage height, 1.41 feet; discharge, 834 second-feet.

Daily gage height, in feet, of Pigeon River at Newport, Tenn., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	Aug.	Sept.	Oct.
1	2.40	1.80	1.30	3.00	2.10			1.30
2	1.90	1.80	1.30	2.70	2.00			1.30
3	1.60	1.90	1.20	7.00	1.90			1.20
4	1.40	1.90	1.20	4.00	1.90	1.00		1.10
5	1.40	3.00	1.80	3.60	2.00	1.40		1.20
6	1.40	2.60	1.40	3.40	2.00	8.90		1.20
7	1.30	2.40	1.20	3.00	1.90	3.20		1.30
8	1.30	2.30	1.30	2.80	1.80	2.30		1.20
9	1.20	2.10	1.80	2.60	1.90	1.90		1.20
10	1.20	2.00	1.70	2.40	1.80	1.40		1.30
11	7.50	2.10	1.60	2.20	1.80	1.40		1.20
12	5.40	2.00	1.60	2.10	1.60	1.50		1.30
13	3.60	1.90	1.50	2.20	2.60	1.40		
14	3.30	1.80	1.50	2.20	1.50	2.90		
15	2.60	1.80	1.30	2.30	1.40	5.00		
16	2.30	1.90	1.30	2.20	1.40			
17	2.10	1.80	1.20	2.20	1.40			
18	2.10	1.80	1.20	2.70	1.50			
19	1.90	1.70	1.30	5.00				
20	1.80	1.70	1.20	4.40				
21	1.80	1.70	1.60	4.30				
22	1.80	1.60	1.50	4.00				
23	1.70	1.60	1.40	3.80				
24	1.60	1.50	1.30	3.60				
25	1.60	1.40	8.00	3.40				
26	1.50	1.40	5.90	3.10				
27	1.60	1.30	4.60	2.60				
28	1.60	1.40	3.80	2.50				
29	1.50		3.60	2.50			1.30	
30	1.60		3.40	2.40			1.30	
31	2.00		3.20					

TENNESSEE RIVER AT KNOXVILLE, TENN.

This station was originally established by the United States Weather Bureau at the old county highway bridge, which has been torn down and replaced by a new bridge. Daily records are kept by the United States Weather Bureau and are furnished to the Geological Survey. The station is described in Water-Supply Paper No. 48, page 193. During 1901 the following measurements were made by Max Hall and others:

List of discharge measurements of Tennessee River at Knoxville, Tenn.

Date.	Hydrographer.	Gage height.	Discharge.
1901.		*Feet.*	*Sec. feet.*
January 25	Max Hall	2.30	9,690
March 22	do	2.12	9,067
April 3	K. T. Thomas	15.40	68,430
May 29	do	8.97	37,581
July 30	do	1.40	7,011
August 17	do	14.00	64,609
November 5	Olin P. Hall	1.15	5,725

Daily gage height, in feet, of Tennessee River at Knoxville, Tenn., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.20	3.30	1.60	6.80	5.50	7.40	4.60	1.80	8.00	2.70	1.20	0.90
2	3.00	3.10	1.50	8.50	4.80	6.20	4.60	1.60	8.40	3.10	1.10	.90
3	2.60	3.20	1.50	15.00	4.40	5.40	4.50	1.60	7.50	2.70	1.10	.90
4	2.30	3.50	1.50	17.10	4.00	4.70	4.40	1.40	5.60	3.80	1.10	1.00
5	2.00	4.50	1.40	14.50	3.70	4.30	4.50	1.30	4.60	3.10	1.10	1.50
6	1.90	5.00	1.70	10.30	3.40	4.00	3.40	2.50	4.10	2.60	1.10	1.80
7	1.80	4.30	1.80	8.00	3.40	3.80	3.70	12.90	3.70	2.20	1.10	1.70
8	1.60	3.60	1.90	6.90	3.20	3.60	4.20	12.20	3.40	2.00	1.10	1.40
9	1.50	3.30	1.70	6.00	3.20	6.90	4.90	7.50	3.20	1.80	1.10	1.30
10	1.50	3.40	2.60	5.40	3.20	5.20	3.70	5.00	3.00	1.70	1.10	1.40
11	4.40	3.80	3.70	4.80	3.30	4.30	3.00	4.00	2.80	1.70	1.00	1.50
12	13.00	4.40	3.50	4.30	3.50	4.00	2.60	3.10	2.90	1.60	1.00	2.00
13	16.00	3.90	3.60	4.00	3.60	3.50	2.40	4.20	3.00	2.00	1.00	2.00
14	13.50	3.50	3.00	4.50	3.40	3.30	2.20	10.70	3.00	2.30	1.10	2.00
15	8.20	3.00	2.60	5.50	3.00	3.80	2.10	17.20	3.00	2.60	1.00	13.00
16	5.80	2.70	2.30	5.50	2.70	6.60	2.20	16.20	3.00	2.40	1.00	21.00
17	4.80	2.60	2.10	4.60	2.60	10.20	2.10	14.30	3.20	2.00	.90	14.20
18	4.00	2.50	2.00	4.30	2.40	7.40	2.50	13.20	3.50	1.80	.90	8.40
19	3.50	2.30	1.90	4.10	3.00	7.20	2.40	12.00	5.50	1.70	.90	5.80
20	3.00	2.20	1.80	7.10	4.70	6.10	2.60	10.50	4.80	1.60	.90	4.30
21	2.80	2.10	1.80	12.80	4.90	5.00	2.40	10.30	3.60	1.60	.80	3.00
22	2.60	2.00	2.30	16.20	17.00	6.70	2.20	10.70	3.00	1.50	.80	2.50
23	2.40	1.90	2.40	12.80	32.00	6.00	2.00	8.40	2.70	1.40	.90	2.80
24	2.40	1.80	2.20	11.90	28.20	8.10	1.80	8.50	2.50	1.40	1.00	4.30
25	2.30	1.70	2.10	11.10	12.00	8.10	1.60	7.80	2.40	1.30	1.00	4.70
26	2.20	1.50	5.60	10.50	9.60	6.50	1.50	6.80	2.30	1.30	1.40	4.90
27	2.20	1.40	16.00	10.00	9.20	5.50	1.40	7.20	2.00	1.30	1.30	11.60
28	2.20	1.70	14.20	8.90	9.80	4.60	1.50	6.50	1.90	1.20	1.10	14.80
29	2.60	.....	10.30	7.80	8.70	4.00	1.70	6.50	1.90	1.20	1.00	17.20
30	2.60	.....	7.60	6.40	9.30	4.00	1.40	7.20	2.00	1.20	.90	29.50
31	2.90	.....	7.20	.....	8.80	.....	1.60	7.60	.....	1.20	.....	31.00

TUCKASEGEE RIVER AT BRYSON, N. C.

This station is described in Water-Supply Paper No. 48, page 188. Results of measurements during 1900 will be found in the Twenty-second Annual Report, Part IV, page 223. During 1901 the following measurements were made by E. W. Myers and R. E. Shuford:

List of discharge measurements of Tuckasegee River at Bryson, N. C.

Date.	Hydrographer.	Gage height.	Discharge.
1901.		*Feet.*	*Sec. feet.*
January 12	R. E. Shuford	5.45	10,420
February 22	do	1.60	906
April 17	E. W. Myers	2.43	2,459
May 27	R. E. Shuford	3.00	3,926
July 11	do	1.65	1,024
August 17	do	5.40	9,512
September 19	E. W. Myers	2.25	2,048
November 7	R. E. Shuford	1.35	853
December 11	do	1.40	910

Daily gage height, in feet, of Tuckasegee River at Bryson, N. C., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.00	1.70	1.60	2.70	2.40	2.50	1.90	1.40	2.80	1.70	1.40	1.20
2	1.90	1.70	1.60	5.60	2.40	2.40	2.00	1.35	2.60	1.70	1.40	1.20
3	1.80	2.20	1.50	4.40	2.30	2.40	2.40	1.30	2.45	1.70	1.35	1.80
4	1.70	3.00	1.50	3.80	2.30	2.30	1.80	1.30	2.40	1.65	1.35	1.50
5	1.65	2.30	2.30	3.50	2.20	2.30	1.80	1.50	2.50	1.60	1.35	1.40
6	1.60	2.00	1.60	3.30	2.20	2.20	2.60	7.00	2.20	1.60	1.30	1.40
7	1.60	2.00	1.50	3.00	2.20	2.60	2.00	3.50	2.10	1.60	1.30	1.30
8	1.55	1.90	1.60	2.80	2.20	2.30	2.20	2.00	2.00	1.55	1.30	1.30
9	1.55	2.60	2.60	2.70	2.10	2.20	1.80	1.80	1.90	1.55	1.30	1.50
10	2.60	2.10	3.60	2.60	2.00	2.10	1.70	1.80	2.00	1.55	1.30	2.40
11	7.10	2.10	2.50	2.50	2.00	2.00	1.60	1.80	1.80	1.50	1.40	1.70
12	4.50	2.00	2.10	2.30	1.90	2.20	1.55	2.30	2.80	1.50	1.30	1.40
13	3.20	2.00	2.00	3.00	1.90	2.30	1.50	4.10	2.10	2.50	1.30	1.50
14	2.80	1.90	1.90	2.80	1.90	3.00	1.50	3.60	2.00	1.80	1.30	8.80
15	2.60	1.90	1.80	2.60	1.80	2.50	1.50	5.00	1.90	1.60	1.25	4.50
16	2.30	1.85	1.80	2.50	1.80	2.50	1.55	4.50	1.80	1.60	1.25	3.80
17	2.20	1.80	1.70	2.40	1.80	2.30	1.50	5.15	3.80	1.50	1.25	2.60
18	2.00	1.80	1.70	2.40	1.80	2.30	2.00	4.50	2.60	1.50	1.25	2.30
19	1.95	1.80	1.70	2.60	2.90	2.20	1.70	4.60	2.20	1.45	1.20	2.10
20	1.90	1.70	1.90	4.30	2.30	2.20	1.70	3.40	2.10	1.45	1.20	2.10
21	1.90	1.60	2.80	3.70	8.25	2.60	1.65	3.50	2.00	1.45	1.20	1.90
22	1.80	1.60	1.90	3.20	5.40	2.20	1.50	5.00	1.90	1.40	1.20	2.00
23	1.80	1.50	1.90	3.00	3.50	2.00	1.50	3.80	1.85	1.40	1.50	2.00
24	2.00	1.50	2.10	2.80	3.00	2.10	1.45	3.40	1.80	1.40	1.40	2.00
25	1.80	1.50	5.00	2.80	3.35	3.00	1.40	3.00	1.75	1.40	1.30	2.00
26	1.70	1.50	6.75	2.70	3.30	2.10	1.40	2.80	1.75	1.40	1.30	2.10
27	2.00	1.50	4.00	2.70	3.00	2.00	1.50	3.40	1.80	1.40	1.25	3.50
28	1.70	1.50	3.30	2.70	2.90	2.00	1.40	3.60	1.80	1.40	1.25	3.20
29	1.60	.....	3.00	2.60	2.80	2.00	1.40	3.40	1.80	1.40	1.20	9.00
30	2.00	.....	3.10	2.50	2.90	2.00	1.40	3.00	1.80	1.40	1.20	4.80
31	1.80	.....	2.80	.....	2.80	.....	1.50	3.00	.....	1.40	.....	3.80

LITTLE TENNESSEE RIVER AT JUDSON, N. C.

This station is described in Water-Supply Paper No. 48, page 189. Records of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 224. During 1901 the following measurements were made by E. W. Myers and R. E. Shuford:

February 22: Gage height, 3.45 feet; discharge, 1,444 second-feet.
April 18: Gage height, 4.28 feet; discharge, 2,319 second-feet.
September 19: Gage height, 5 feet; discharge, 4,200 second-feet.
December 12: Gage height, 2.95 feet; discharge, 1,062 second-feet.

Daily gage height, in feet, of Little Tennessee River at Judson, N. C., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.43	3.59	3.22	4.32	3.48	4.61	3.35	3.50	4.39	3.21	3.10	2.78
2	3.57	3.59	3.21	8.40	3.46	3.92	3.28	3.40	4.26	3.19	3.11	2.79
3	3.59	3.62	3.18	6.33	3.46	3.80	3.30	3.50	3.72	3.19	2.98	2.79
4	3.63	4.32	3.19	5.44	3.39	3.78	4.61	3.11	3.72	3.16	2.99	2.78
5	3.68	4.23	3.19	4.62	3.38	3.78	4.28	3.10	3.61	3.13	2.98	2.76
6	3.69	3.84	3.17	4.28	3.56	3.64	3.96	4.63	3.60	3.15	2.98	2.76
7	3.60	3.61	3.18	4.26	3.36	3.62	3.82	7.32	3.58	3.14	2.94	2.75
8	3.60	3.57	3.18	4.25	3.34	3.60	4.36	6.28	3.49	3.14	2.94	2.74
9	3.58	3.58	3.45	4.90	3.35	3.54	3.91	4.23	3.47	3.80	2.94	2.75
10	5.62	3.56	5.39	3.84	3.29	3.53	3.79	3.71	3.42	3.70	2.96	3.49
11	8.40	3.56	5.80	3.83	3.29	3.53	3.76	3.98	3.42	3.40	2.94	5.92
12	5.30	3.42	4.39	3.81	3.26	3.51	3.54	3.94	3.40	4.51	2.93	3.51
13	4.31	3.42	4.20	4.53	3.25	3.49	3.42	6.40	3.31	3.64	2.93	3.48
14	4.31	3.40	3.61	4.28	3.25	4.72	3.39	7.15	3.30	3.34	2.90	4.64
15	3.42	3.32	3.42	4.22	3.26	6.41	3.38	7.28	3.28	3.31	2.90	13.59
16	3.41	3.33	3.40	3.96	3.23	5.33	3.38	6.39	3.28	3.28	2.89	8.42
17	3.38	3.38	3.39	3.84	2.23	5.31	3.36	9.54	3.24	3.22	2.87	6.38
18	3.21	3.37	3.39	3.82	3.19	4.96	3.33	6.42	3.25	3.22	2.87	4.22
19	3.22	3.37	3.37	5.00	4.28	4.92	3.29	5.38	3.23	3.21	2.84	4.23
20	3.20	3.38	3.33	8.46	12.32	4.83	3.22	4.93	3.21	3.19	2.83	4.21
21	3.18	3.38	4.53	6.38	8.46	4.61	3.21	4.84	3.21	3.19	2.85	4.19
22	3.18	3.38	4.39	5.46	5.39	4.34	3.21	4.83	3.23	3.18	2.84	3.91
23	3.18	3.27	3.78	4.93	4.93	4.28	3.20	10.32	3.25	3.14	2.96	3.92
24	3.21	3.22	3.46	4.61	4.68	4.21	3.18	6.40	3.25	3.13	2.88	3.98
25	3.19	3.21	3.41	4.45	4.23	3.94	3.14	5.32	3.24	3.13	2.86	3.93
26	3.18	3.21	10.54	3.93	4.19	3.65	3.11	5.28	3.22	3.13	2.86	3.90
27	3.92	3.23	8.40	3.82	4.19	3.62	3.11	4.73	3.22	3.14	2.85	3.81
28	3.98	3.22	5.33	3.61	4.13	3.48	3.90	7.39	3.23	3.13	2.86	5.31
29	3.69	.....	4.09	3.60	4.12	3.34	3.90	7.42	3.22	3.12	2.84	13.92
30	3.69	.....	4.15	3.54	4.12	3.34	3.60	6.51	3.22	3.11	2.81	12.28
31	3.67	.....	4.20	.....	5.08	.....	3.50	5.41	.....	3.11	.....	10.92

HIWASSEE RIVER AT MURPHY, N. C.

This station is described in Water-Supply Paper No. 48, page 190. The observer is William Mingus, of Murphy. Records of measurements during 1900 will be found in the Twenty-second Annual Report, Part IV, page 224. During 1901 the following measurements were made by E. W. Myers and R. E. Shuford:

List of discharge measurements of Hiwassee River at Murphy, N. C.

Date.	Hydrographer.	Gage height.	Discharge.
1901.		*Feet.*	*Sec.-feet.*
February 24	R. E. Shuford	5.70	725
April 17	E. W. Myers	6.15	1,522
May 12	R. E. Shuford	6.40	2,107
July 12	do	5.45	665
August 16	do	8.00	4,974
September 20	E. W. Myers	6.02	1,106
Do	do	6.02	1,324
Do	do	6.02	1,257
Do	do	6.02	1,166
Do	do	6.02	1,246
Do	do	6.03	1,182
November 8	R. E. Shuford	5.25	462
December 13	do	5.32	480

Daily gage height, in feet, of Hiwassee River at Murphy, N. C., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	6.00	6.05	5.60	6.35	6.15	6.35	6.00	5.30	6.70	5.60	5.25	5.20
2	5.90	5.95	5.60	7.65	6.10	6.20	5.90	5.25	6.40	5.60	5.25	5.20
3	5.80	5.90	5.55	7.60	6.05	6.10	5.65	5.20	6.25	5.60	5.25	5.30
4	5.70	7.55	5.55	7.10	6.00	6.05	5.60	5.20	6.20	5.50	5.30	5.35
5	5.60	6.75	5.70	6.75	6.00	6.00	5.55	6.20	6.15	5.50	5.30	5.20
6	5.60	6.40	5.60	6.75	6.05	5.95	5.70	7.65	6.05	5.50	5.30	5.25
7	5.60	6.25	5.55	6.50	5.95	6.10	6.55	7.00	6.00	5.45	5.25	5.20
8	5.50	6.15	5.55	6.40	5.85	5.90	5.75	6.05	5.90	5.40	5.25	5.25
9	5.50	6.95	5.55	6.25	5.85	5.85	5.55	5.75	5.85	5.45	5.25	5.25
10	5.50	6.50	5.60	6.20	5.85	5.80	5.50	5.60	5.80	5.40	5.25	6.15
11	8.80	6.40	6.50	6.10	5.80	5.80	5.45	5.85	6.00	5.40	5.25	5.55
12	9.20	6.30	6.10	6.10	5.75	5.95	5.45	6.55	5.80	5.40	5.20	5.40
13	7.50	6.25	5.95	6.15	5.75	5.85	5.40	5.75	6.00	6.20	5.40	5.40
14	6.85	6.15	5.85	6.55	5.70	6.50	5.40	7.95	5.80	5.50	5.30	6.30
15	6.50	6.05	5.75	6.35	5.65	6.50	5.45	7.30	5.70	5.45	5.20	9.10
16	6.30	6.00	5.75	6.20	5.65	6.35	5.80	7.90	5.90	5.40	5.20	6.80
17	6.20	5.90	5.70	6.15	5.65	6.30	5.40	8.15	7.20	5.40	5.20	6.70
18	6.10	5.85	5.65	6.10	5.60	6.10	5.40	8.45	6.75	5.40	5.25	6.00
19	5.90	5.85	5.60	6.55	6.70	6.00	7.10	7.35	6.20	5.40	5.25	5.90
20	5.85	5.80	5.60	11.40	7.20	6.05	5.65	7.05	6.00	5.35	5.25	5.80
21	5.85	5.75	5.95	7.90	7.50	5.85	5.45	8.15	5.90	5.35	5.20	5.70
22	5.90	5.75	5.75	7.25	10.60	5.80	5.65	8.00	5.80	5.35	5.20	5.75
23	5.80	5.75	5.65	6.95	7.75	5.75	5.40	12.70	5.75	5.35	5.25	5.70
24	6.05	5.70	5.95	6.70	7.10	5.70	5.35	8.25	5.70	5.30	5.45	5.90
25	5.90	5.65	5.80	6.65	6.85	5.70	5.45	7.35	5.65	5.30	5.30	5.85
26	5.85	5.70	10.80	6.50	6.55	6.10	5.30	6.95	5.65	5.30	5.20	5.85
27	5.90	5.65	8.20	6.40	6.50	5.70	5.65	6.75	5.60	5.30	5.20	7.50
28	6.05	5.60	7.20	6.35	6.35	6.20	5.30	6.85	5.60	5.30	5.15	6.55
29	5.95	.....	6.80	6.20	6.35	6.05	5.50	7.00	5.75	5.30	5.15	13.30
30	6.00	.....	6.60	6.15	6.20	5.75	5.35	6.80	5.60	5.30	5.20	9.10
31	6.20	.....	6.50	.....	6.75	.....	5.50	6.70	.....	5.25	.....	7.50

NOTTELY RIVER AT RANGER, N. C.

The station was established by Olin P. Hall, on February 16, 1901. It is situated at the Nottely wagon bridge, about one-half mile from Ranger, N. C., on the Murphy Division of the Atlanta, Knoxville and Northern Railway. The bridge is an old wooden structure, about 125 feet in length between abutments and about 20 feet above low water. The bridge is supported on 2 wooden bents, dividing it into 3 spans. The gage is a 1 by 3 inch pine board in 2 sections, each 8 feet long, graduated to feet and tenths and fastened to the upstream side of the right wooden abutment. The bench mark is the top of the downstream end of cap of right abutment; its elevation is 20 feet above the zero of the gage. The initial point for soundings is the edge of the right abutment on the downstream side. The observer is C. H. Foote, a clerk in the store at Ranger, who lives about one-eighth mile from the gage. The following discharge measurements were made during 1901 by Olin P. Hall:

February 16: Gage height. 4.20 feet; discharge, 649 second-feet.
April 4: Gage height, 5.40 feet; discharge, 970 second-feet.
June 28: Gage height, 4.12 feet; discharge, 612 second-feet.
October 31: Gage height, .40 feet; discharge, 364 second-feet.

Daily gage height, in feet, of Nottely River at Ranger, N. C., for 1901.

Day.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	3.60	4.80	4.40	6.00	5.00	3.50	6.00	4.10	3.40	3.40
2	.....	3.60	8.80	4.30	4.80	5.20	3.40	5.20	4.00	3.40	3.40
3	.....	3.60	7.00	4.30	4.60	4.20	3.30	5.00	3.90	3.40	3.40
4	.....	3.60	5.60	4.20	5.00	4.10	3.20	4.80	3.90	3.60	3.40
5	.....	3.80	5.20	4.20	4.60	4.00	3.10	5.00	3.80	3.40	3.40
6	.....	3.70	5.10	4.20	5.40	3.90	9.60	4.80	3.80	3.40	3.40
7	.....	3.60	4.90	4.10	4.80	4.80	9.20	4.60	4.00	3.40	3.40
8	.....	3.60	4.70	4.10	4.40	4.60	4.80	4.50	3.90	3.40	3.40
9	.....	3.80	4.60	4.10	4.20	4.00	4.60	4.40	3.80	3.30	3.40
10	.....	5.20	4.50	4.00	4.10	3.80	4.20	4.20	3.80	3.30	6.00
11	.....	5.60	4.30	3.90	4.00	3.70	4.80	4.80	3.70	3.30	4.50
12	.....	4.20	4.20	3.90	3.90	3.60	4.60	4.40	3.60	3.30	3.70
13	.....	4.10	5.20	3.80	4.80	3.50	4.80	5.00	4.60	3.60	3.40
14	.....	4.00	5.00	3.80	7.00	3.50	14.40	4.60	4.00	3.40	6.00
15	.....	3.90	4.90	3.70	5.60	3.40	9.60	4.40	3.80	3.40	13.00
16	4.20	3.90	4.70	3.60	5.80	4.00	9.20	5.00	3.70	3.40	6.00
17	4.10	3.80	4.50	3.60	5.40	3.90	10.00	11.00	3.70	3.40	5.00
18	4.00	3.80	4.40	3.50	5.60	3.80	10.80	6.20	3.60	3.40	4.50
19	4.00	3.70	7.80	4.20	4.80	9.80	8.00	5.00	3.60	3.40	4.00
20	3.90	3.70	8.80	6.40	5.00	4.20	6.80	4.80	3.50	3.40	3.40
21	3.80	3.60	6.20	11.80	4.60	4.00	10.00	4.60	3.50	3.40	3.40
22	3.80	3.60	5.70	15.00	4.40	3.80	11.00	4.40	3.50	3.40	3.40
23	3.70	4.80	5.50	8.50	4.20	3.60	15.80	4.30	3.40	3.40	4.00
24	3.70	5.40	5.20	5.60	4.10	3.50	8.40	4.20	3.40	4.00	4.50
25	3.70	6.20	5.00	5.40	4.00	3.50	6.20	4.10	3.40	3.40	4.00
26	3.70	13.50	4.80	5.20	5.20	3.40	6.40	4.00	3.30	3.40	4.00
27	3.70	8.20	4.70	5.00	4.10	3.80	6.40	3.90	3.30	3.40	6.50
28	3.70	6.20	4.60	4.90	4.00	3.50	6.20	4.20	3.30	3.40	6.00
29	.....	5.40	4.50	4.80	4.00	3.80	6.00	4.40	3.30	3.40	20.00
30	.....	5.20	4.40	4.70	4.60	3.60	5.80	4.10	3.40	3.40	10.00
31	.....	5.20	.....	5.00	.....	3.70	5.60	.....	3.40	.....	6.00

HIWASSEE RIVER AT RELIANCE, TENN.

This station was established by O. P. Hall on August 17, 1900, and is situated at the Knoxville and Northern Railroad bridge. It is described in Water-Supply Paper No. 48, page 191. Results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 225. During 1901 the following measurements were made by O. P. Hall and Max Hall:

List of discharge measurements of Hiwassee River at Reliance, Tenn.

Date.	Hydrographer.	Gage height.	Discharge.
1901.		*Feet.*	*Sec. feet.*
February 18	Olin P. Hall	2.01	2,698
February 27	Max Hall	1.77	2,104
April 2	Olin P. Hall	4.55	12,025
June 24	do	1.98	2,620
August 21	do	3.74	8,229
October 30	do	1.43	1,522

Daily gage height, in feet, of Hiwassee River at Reliance, Tenn., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.50	2.40	1.80	2.60	2.30	2.80	2.40	1.50	3.10	1.80	1.50	1.30
2	2.20	2.10	1.80	4.30	2.30	2.50	2.10	1.40	2.60	1.90	1.40	1.30
3	2.10	2.30	1.60	4.50	2.20	2.40	2.00	1.30	2.50	1.70	1.40	1.40
4	1.90	4.70	1.70	3.50	2.20	2.40	2.00	1.30	2.40	1.70	1.40	1.60
5	1.90	3.20	1.90	2.90	2.10	2.30	2.00	1.30	2.40	1.70	1.50	1.50
6	1.80	2.80	1.80	2.90	2.10	2.20	1.80	2.10	2.20	1.70	1.40	1.40
7	1.70	2.50	1.70	2.80	2.10	2.60	2.00	5.40	2.20	1.60	1.40	1.40
8	1.70	2.40	1.60	2.60	2.00	2.30	2.10	2.50	2.10	1.60	1.40	1.40
9	1.60	2.50	1.80	2.50	2.00	2.10	2.00	2.00	2.10	1.70	1.30	1.50
10	1.70	2.70	3.00	2.40	2.10	2.10	1.80	1.80	2.00	1.70	1.40	1.70
11	7.00	2.50	3.30	2.30	2.00	2.00	1.70	1.80	2.00	1.60	1.30	2.00
12	8.50	2.40	2.50	2.30	2.00	2.10	1.60	1.90	2.00	1.50	1.40	1.70
13	4.50	2.30	2.20	2.30	1.90	2.10	1.60	2.30	2.40	1.80	1.70	1.60
14	3.50	2.30	2.10	3.40	1.90	2.70	1.50	4.80	2.10	1.90	1.50	6.00
15	3.00	2.30	2.00	2.80	1.90	2.50	1.60	5.00	2.00	1.70	1.40	8.80
16	2.80	2.20	1.90	2.50	1.80	3.50	1.60	6.00	1.90	1.60	1.30	3.50
17	2.50	2.00	1.90	2.40	1.80	2.90	1.70	4.50	2.80	1.50	1.40	2.70
18	2.40	2.00	1.80	2.40	1.80	2.60	1.60	5.50	3.80	1.60	1.30	2.40
19	2.10	2.00	1.80	5.40	2.50	2.40	1.70	5.50	2.80	1.60	1.30	2.10
20	2.10	1.90	1.70	7.30	5.10	2.50	2.20	4.20	2.40	1.50	1.40	2.10
21	2.00	1.90	1.90	4.40	4.80	2.30	1.80	3.60	2.30	1.50	1.40	2.00
22	2.10	1.80	2.00	3.40	9.90	2.20	1.60	5.00	2.10	1.40	1.30	1.90
23	2.00	1.80	1.80	3.20	4.50	2.10	1.60	9.10	2.10	1.50	1.40	2.10
24	2.10	1.80	1.90	3.00	3.50	2.00	1.50	4.90	2.00	1.50	1.60	2.50
25	2.40	1.70	2.10	2.80	3.10	2.80	1.40	3.70	2.00	1.50	1.50	2.10
26	2.10	1.40	9.30	2.70	2.90	2.10	1.50	3.00	2.00	1.40	1.40	2.20
27	2.10	1.80	5.60	2.60	2.80	2.10	1.70	3.00	1.90	1.40	1.40	3.00
28	2.50	1.70	3.80	2.50	2.60	1.90	1.50	3.00	1.90	1.40	1.40	3.00
29	2.00	.....	3.10	2.40	2.60	2.20	1.50	3.30	2.00	1.50	1.30	7.70
30	2.10	.....	2.90	2.40	2.50	2.20	1.50	3.20	1.90	1.40	1.30	8.00
31	2.70	.....	2.90	.....	3.00	.....	1.60	2.90	.....	1.30		5.40

HIWASSEE RIVER AT CHARLESTON, TENN.

This station was originally established by the United States Engineer Corps, but is now maintained as a half-year station by the United States Weather Bureau, and the remainder of the year by the United States Geological Survey. It is described in Water-Supply Paper No. 48, page 192, where will also be found the records of measurements made during 1900. Results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 225. During 1901 the following measurements were made by Max Hall and others:

List of discharge measurements of Hiwassee River at Charleston, Tenn.

Date.	Hydrographer.	Gage height.	Discharge.
1901.		*Feet.*	*Sec. feet.*
January 26	Max Hall	3.12	5,714
April 2	K. T. Thomas	12.20	19,128
March 22	Max Hall	2.82	5,031
May 30	K. T. Thomas	4.15	6,702
July 29	do	1.75	3,021
August 17	do	15.10	21,251

Daily gage height, in feet, of Hiwassee River at Charleston, Tenn., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4.60	4.20	2.10	4.80	3.70	5.70	3.00	1.60	4.60	2.30	1.50	1.20
2	3.50	3.50	2.20	9.00	3.60	4.90	3.30	1.40	4.20	2.20	1.40	1.20
3	3.00	3.30	2.10	14.70	3.40	4.00	3.20	1.30	4.00	2.20	1.40	1.30
4	2.70	9.10	2.00	10.10	3.30	3.70	2.50	1.20	3.40	2.10	1.50	1.70
5	2.50	7.70	2.60	7.70	3.20	3.60	2.30	1.20	3.30	2.00	1.50	1.70
6	2.30	5.30	2.80	6.40	3.10	3.30	2.20	1.80	3.20	1.90	1.50	1.50
7	2.20	4.50	2.20	5.50	3.20	5.30	2.60	10.80	2.90	1.90	1.40	1.50
8	2.10	4.00	2.10	4.70	3.00	4.10	3.20	4.60	2.80	1.80	1.40	1.50
9	2.00	4.00	2.20	4.20	2.90	3.30	2.80	2.50	2.70	1.80	1.40	1.40
10	2.00	5.00	8.00	3.90	2.80	3.10	2.30	2.00	2.60	1.70	1.30	2.00
11	8.50	4.10	8.70	3.70	2.80	3.00	2.10	2.30	2.50	1.70	1.30	3.20
12	23.00	3.80	6.00	3.50	2.70	2.90	1.90	2.50	2.90	1.70	1.30	2.10
13	18.30	3.50	4.40	3.50	2.60	3.30	1.90	3.60	3.40	3.20	1.70	1.80
14	10.80	3.30	3.50	6.20	2.60	3.90	1.80	9.50	3.30	3.20	1.80	2.80
15	7.50	3.10	3.10	5.50	2.50	6.50	1.80	15.00	3.30	2.20	1.40	22.20
16	5.40	3.00	2.90	4.50	2.40	8.20	1.80	16.60	2.70	1.80	1.30	16.00
17	4.40	2.90	2.70	4.00	2.30	6.10	2.10	16.40	4.40	1.80	1.30	8.90
18	3.90	2.80	2.60	3.80	2.30	5.00	1.90	14.40	10.70	1.70	1.30	6.20
19	3.40	2.60	2.50	8.20	3.40	4.10	1.80	12.80	6.00	1.70	1.30	3.60
20	3.10	2.60	2.40	19.40	13.00	3.70	4.10	8.20	4.00	1.60	1.30	3.10
21	2.90	2.50	2.60	15.30	9.20	3.60	2.00	7.10	3.30	1.60	1.40	2.20
22	2.90	2.40	3.00	9.90	23.80	3.20	1.80	10.10	3.00	1.60	1.30	2.10
23	2.90	2.40	2.60	8.00	19.00	3.00	1.80	17.40	2.70	1.60	1.30	2.70
24	3.10	2.30	2.30	6.80	11.70	2.80	1.60	16.10	2.60	1.60	1.80	4.00
25	4.10	2.20	2.80	5.70	11.70	2.70	1.50	8.70	2.50	1.60	1.90	3.70
26	3.30	2.20	17.60	5.10	9.70	2.80	1.50	6.40	2.40	1.50	1.50	3.20
27	3.00	2.20	19.90	4.80	5.40	3.30	1.50	5.50	2.30	1.50	1.40	5.00
28	3.50	2.10	11.00	4.40	4.80	2.50	1.70	5.60	2.20	1.50	1.30	7.40
29	3.30	.....	7.30	4.20	4.60	2.80	1.80	5.60	2.50	1.50	1.20	14.50
30	3.10	.....	5.60	3.90	4.30	3.10	1.70	5.40	2.50	1.50	1.20	25.20
31	5.00	.....	5.70	.....	5.50	.....	1.60	4.80	.....	1.50	.....	20.20

TOCCOA RIVER NEAR BLUERIDGE, GA.

This station, which was established by B. M. Hall November 25, 1898, is at the Morganton bridge, about 4 miles east of the town of Blueridge. It is described in Water-Supply Paper No. 48, page 193. Results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 227. During 1901 the following measurements were made by O. P. Hall:

January 23: Gage height, 3.05 feet; discharge, 714 second-feet.
April 5: Gage height, 3.50 feet; discharge, 1,051 second-feet.
June 26: Gage height, 3.44 feet; discharge, 993 second-feet.
August 23: Gage height, 6.90 feet; discharge, 4,697 second-feet.
October 31: Gage height, 2.62 feet; discharge, 592 second-feet.

Daily gage height, in feet, of Toccoa River near Blueridge, Ga., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.00	3.00	3.00	4.00	3.60	4.00	3.00	3.50	4.00	3.20	2.80	2.80
2	3.00	3.00	3.00	4.00	3.60	4.00	3.00	3.20	4.00	3.00	2.80	2.80
3	3.00	4.00	3.00	4.00	3.50	4.00	3.00	3.00	4.00	3.00	2.70	2.80
4	3.00	4.00	3.00	4.00	3.50	4.00	3.00	3.00	4.00	3.00	2.70	2.80
5	3.00	3.50	3.00	4.00	3.50	3.80	3.00	6.00	4.00	3.00	2.70	2.80
6	3.00	3.50	3.00	4.00	3.50	3.80	3.00	4.00	4.00	3.00	2.70	2.90
7	2.80	3.40	3.00	3.80	3.50	3.60	3.00	4.00	4.00	3.00	2.70	3.00
8	2.80	3.40	3.00	3.80	3.50	3.60	3.00	4.00	4.00	3.00	2.60	3.00
9	3.00	3.00	3.50	3.80	3.40	3.50	3.00	3.50	4.00	3.00	2.60	3.00
10	4.00	3.00	3.40	3.80	3.40	3.50	3.00	3.50	3.60	3.00	2.60	3.00
11	7.40	3.00	3.30	3.70	3.40	3.50	3.00	3.50	3.60	3.00	2.60	4.00
12	5.00	3.00	3.00	3.70	3.20	3.50	3.00	4.00	6.60	3.00	2.60	5.00
13	4.00	3.00	3.00	3.70	3.20	3.50	3.00	4.00	3.60	3.00	2.60	5.00
14	3.80	3.00	3.00	3.60	3.00	3.50	3.00	4.00	3.50	3.00	2.60	12.00
15	3.80	3.00	3.00	3.60	3.00	3.50	3.00	5.00	2.50	3.00	2.60	5.00
16	3.60	3.00	3.00	3.60	3.00	3.40	3.00	5.00	3.50	3.00	2.60	4.80
17	3.60	3.00	3.00	3.50	3.00	3.40	3.00	5.00	3.40	3.00	2.70	4.80
18	3.40	3.00	3.00	3.50	3.00	3.40	4.00	4.50	3.40	2.80	2.70	4.60
19	3.40	3.00	3.00	5.50	3.00	3.20	4.00	4.50	3.00	2.80	2.70	4.60
20	3.20	2.80	3.00	4.50	11.00	3.20	3.50	4.50	3.00	2.80	2.70	4.60
21	3.00	2.80	3.00	4.00	6.00	3.20	3.00	4.00	3.00	2.80	2.70	4.00
22	3.00	2.80	3.00	4.00	6.00	3.20	3.00	14.00	3.00	2.80	2.70	4.00
23	3.00	2.80	3.00	4.00	5.00	3.00	3.00	8.00	3.00	2.80	2.70	4.00
24	3.00	3.00	3.00	4.00	5.00	3.00	3.00	6.00	3.00	2.80	2.70	4.00
25	4.00	3.00	7.00	3.80	5.00	3.00	3.00	5.00	3.00	2.80	2.70	4.00
26	3.50	3.00	6.00	3.80	4.00	3.00	3.00	4.00	3.00	2.80	2.70	5.00
27	3.50	3.00	4.00	3.80	3.60	3.00	3.00	4.00	3.00	2.80	2.70	5.50
28	3.20	3.00	4.00	3.60	3.60	3.00	3.00	4.00	4.00	2.80	2.70	6.00
29	3.20	.....	4.00	3.60	3.60	3.00	3.00	4.00	4.00	2.80	2.70	10.00
30	3.20	.....	4.00	3.60	3.60	3.00	3.00	4.00	3.50	2.80	2.70	16.00
31	3.00	.....	4.00	.....	4.00	.....	4.00	4.00	.....	2.80	.....	5.40

TENNESSEE RIVER AT CHATTANOOGA, TENN.

This station was established in 1879 at the foot of Lookout street, just below Chattanooga Island, by the Signal Corps of the United States Army; but since July 1, 1891, it has been in charge of the Weather Bureau. The station is described in Water-Supply Paper No. 48, page 195. Results of measurements made during 1900 will be found in the Twenty-second Annual Report, Part IV, page 228. During 1901 the following measurements were made by Max Hall and K. T. Thomas:

January 24: Gage height, 5.60 feet; discharge, 30,317 second-feet.
April 4: Gage height, 24.20 feet; discharge, 155,457 second-feet.
July 31: Gage height, 2.80 feet; discharge, 15,393 second-feet.
August 18: Gage height, 31.70 feet; discharge, 198,718 second-feet.

Daily gage height, in feet, of Tennessee River at Chattanooga, Tenn., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	5.20	6.50	3.70	12.40	10.80	12.00	6.00	2.80	9.90	4.20	2.60	2.30
2	5.70	6.70	3.70	13.20	9.30	11.10	5.90	2.80	9.80	4.50	2.60	2.20
3	5.80	7.20	3.70	19.70	8.50	9.80	6.30	2.90	9.70	4.60	2.50	2.30
4	5.60	8.70	3.70	24.10	7.60	8.50	6.40	2.80	10.30	4.50	2.50	2.50
5	5.10	10.10	3.80	23.90	7.00	7.70	6.00	2.60	9.40	4.40	2.50	2.50
6	4.70	10.00	4.00	22.40	6.70	6.90	5.20	2.60	7.90	4.80	2.50	2.50
7	4.40	9.40	4.10	18.90	6.40	6.90	5.10	3.20	6.90	4.50	2.40	3.00
8	4.10	8.90	4.10	14.20	6.20	6.90	5.40	9.10	6.40	4.10	2.40	3.20
9	3.90	8.50	4.00	11.80	5.99	6.50	5.60	12.20	5.90	3.90	2.40	3.20
10	3.80	7.70	7.00	10.30	5.60	6.90	6.30	9.90	5.50	3.70	2.40	3.50
11	6.10	7.60	9.80	9.20	5.60	8.20	6.60	7.30	5.30	3.40	2.40	3.50
12	15.40	7.00	11.20	8.40	5.40	7.40	5.60	5.80	5.10	3.40	2.40	4.00
13	26.60	7.10	9.70	7.90	5.60	6.40	5.00	5.30	5.70	3.50	2.50	4.10
14	28.10	7.20	8.20	6.80	5.50	6.10	4.40	6.50	5.90	4.00	2.50	4.70
15	25.30	7.00	7.30	9.80	5.50	6.40	4.10	14.00	6.00	4.30	2.50	17.90
16	19.50	6.40	6.40	10.30	5.40	7.50	3.60	27.30	6.10	4.10	2.50	26.80
17	12.70	5.80	5.80	10.20	5.20	8.90	3.70	32.80	6.30	4.10	2.40	28.80
18	9.70	5.30	5.40	9.60	4.90	9.80	3.90	32.60	8.80	4.00	2.40	26.70
19	8.10	5.10	5.00	10.80	5.30	9.30	3.70	28.60	9.90	3.70	2.30	19.90
20	7.20	5.00	4.70	21.10	8.00	8.90	3.70	23.40	9.30	3.30	2.30	11.40
21	6.40	4.90	4.70	26.50	10.20	8.40	4.20	18.60	8.30	3.10	2.20	8.30
22	5.90	4.70	4.80	24.70	20.20	7.70	3.90	17.00	7.40	3.10	2.10	6.60
23	5.40	4.50	5.20	23.00	26.50	10.10	3.70	16.50	6.40	3.10	2.20	5.70
24	5.60	4.40	5.00	22.20	29.70	9.50	3.50	18.50	5.60	3.00	2.50	5.80
25	5.80	4.20	5.00	19.00	32.40	7.60	3.10	16.50	5.20	3.00	2.50	6.90
26	5.80	4.10	7.70	17.10	32.50	9.60	3.00	13.10	4.90	2.90	2.50	7.90
27	5.40	3.80	15.90	14.90	23.50	9.80	2.90	11.00	4.60	2.80	2.60	10.20
28	5.20	3.70	22.30	14.90	13.50	8.40	2.90	10.30	5.40	2.70	2.50	16.00
29	5.20	.....	21.70	14.50	12.10	7.20	2.80	10.70	4.40	2.60	2.50	24.00
30	5.20	.....	18.40	13.80	11.90	6.40	2.80	10.00	4.30	2.50	2.40	32.00
31	5.50	.....	14.70	.....	12.30	.....	2.80	9.80	.....	2.50	.....	37.40

MISCELLANEOUS MEASUREMENTS OF APPALACHIAN STREAMS.

During 1901 a large number of measurements were made of the streams of the Appalachian region by E. W. Myers and assistants, and by B. M. Hall and assistants, in the northern and southern portions of this region, respectively. Measurements made by the latter include the lower tributaries of streams of the Apalachicola and Mobile basins. All of these measurements, with the exception of those made in the Altamaha basin (see page 263), have been published in Water-Supply Paper No. 63, being Part II of Hydrography of the Southern Appalachian Mountain Region, by H. A. Pressey.

MISSISSIPPI RIVER AT ST. PAUL, MINN.

Records of gage heights are maintained by the United States Weather Bureau at St. Paul, and are furnished to the Geological Survey. The station is described in Water-Supply Paper No. 49, page 260.

Daily gage height, in feet, of Mississippi River at St. Paul, Minn., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	.....	.....	5.4	6.0	5.0	6.0	3.8	2.6	2.6	2.7	2.0
2	.....	.....	.....	5.6	6.0	4.9	6.3	3.7	2.8	2.6	2.7	2.1
3	.....	.....	.....	5.6	6.1	4.8	6.4	3.4	2.7	2.6	2.8	1.8
4	.....	.....	.....	5.8	6.1	4.8	6.5	3.3	2.7	2.7	2.7	[illegible]
5	.....	[a]2.0	.....	6.1	6.8	4.7	6.5	3.1	2.6	2.7	2.7	.....
6	.....	.....	[a]3.4	6.5	6.9	4.7	6.6	3.0	2.6	2.6	2.7	.....
7	.....	.....	.....	6.4	7.1	4.5	6.7	3.0	2.6	2.4	2.6	.....
8	[a]2.1	.....	.....	6.5	7.2	4.3	6.9	2.9	2.5	2.4	2.6	.....
9	.....	.....	.....	6.8	7.3	4.2	7.0	2.8	2.4	2.4	2.5	1.2
10	.....	.....	.....	7.2	7.3	4.1	7.1	2.7	2.5	2.4	2.5	.....
11	.....	.....	.....	7.3	7.3	4.2	7.2	2.6	2.6	2.5	2.5	.....
12	.....	.....	.....	7.5	7.1	4.3	7.2	2.4	2.7	2.6	2.6	.....
13	.....	.....	.....	7.2	7.0	4.3	7.2	2.3	2.5	2.6	2.5	.....
14	.....	.....	.....	6.7	7.0	4.1	7.0	2.5	2.5	2.7	2.5	.....
15	.....	[a]2.0	.....	6.5	6.9	4.3	6.9	2.7	2.4	2.9	2.5	[a]1.8
16	[a]2.0	.....	[a]3.8	6.5	6.8	4.3	6.8	2.9	2.3	3.1	2.4	.....
17	.....	.....	.....	6.7	6.7	4.1	6.7	2.9	2.3	3.0	1.9	.....
18	.....	.....	.....	6.6	6.7	4.0	6.6	2.8	2.2	3.0	1.5	.....
19	.....	.....	.....	6.6	6.6	4.0	6.4	2.7	2.1	2.9	1.6	.....
20	.....	.....	.....	6.6	6.5	4.2	6.1	2.6	2.1	2.9	1.6	.....
21	.....	.....	.....	6.5	6.4	4.4	5.8	2.6	2.1	2.9	1.6	.....
22	.....	[a]1.8	.....	6.5	6.2	5.0	5.5	2.6	2.0	2.8	1.6	.....
23	.....	.....	.....	6.5	6.2	5.5	5.3	2.5	2.0	2.8	1.7	.....
24	[a]2.1	.....	.....	6.4	6.1	5.6	5.0	2.5	2.0	2.7	1.7	.....
25	.....	.....	5.4	6.4	5.9	5.7	4.8	2.5	2.1	2.7	1.3	.....
26	.....	.....	5.8	6.3	5.8	5.7	4.5	2.4	2.2	2.6	1.6	.....
27	.....	.....	5.7	6.3	5.6	5.7	4.3	2.5	2.3	2.6	1.5	.....
28	.....	[a]1.7	5.4	6.3	5.4	5.6	4.1	2.6	2.4	2.6	1.4	[a]1.8
29	.....	.....	5.2	6.2	5.3	6.1	4.0	2.6	2.5	2.6	1.3	.....
30	[a]2.0	.....	5.3	6.1	5.2	6.2	3.9	2.6	2.4	2.7	1.5	.....
31	.....	.....	5.3	.....	5.1	.....	3.9	2.6	.....	2.7	.....	.....
Mean	2.0	1.9	5.4	6.5	6.4	4.8	6.0	2.8	2.4	2.7	2.1	2.0

[a] Approximate: river frozen.

GREAT LAKES DRAINAGE.

MAUMEE RIVER NEAR WATERVILLE, OHIO.

This station was established on November 19, 1898, by H. A. Pressey and B. H. Flynn at the highway bridge near Waterville. It is described in Water-Supply Paper No. 49, page 220. The following measurements of discharge were made during 1901 by B. H. Flynn:

April 24: Gage height, 4.52 feet; discharge, 8,239 second-feet.
October 23: Gage height, 2 feet; discharge, 472 second-feet.

Daily gage height, in feet, of Maumee River near Waterville, Ohio, for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.05	2.30	3.00	3.25	3.05	6.00	3.45	1.55	1.60	1.50	1.75	1.65
2	2.05	2.50	3.10	3.10	3.00	5.10	3.15	1.50	1.60	1.50	1.75	1.65
3	2.05	2.50	3.00	3.00	2.55	4.60	2.75	1.40	1.60	1.50	1.70	1.65
4	2.05	2.15	4.30	3.00	2.65	4.10	2.60	1.45	1.60	1.50	1.80	1.85
5	2.10	2.30	5.85	3.05	2.55	3.75	3.75	1.35	1.50	1.40	1.65	1.95
6	2.20	2.85	6.60	3.10	2.45	3.35	4.90	1.40	1.50	1.40	1.65	1.70
7	2.25	3.35	6.30	3.25	2.50	3.05	5.80	1.50	1.60	1.40	1.70	1.65
8	2.15	4.00	5.90	3.40	2.40	2.70	5.15	1.45	1.50	1.40	1.60	1.65
9	2.15	4.65	5.20	3.15	2.60	2.55	4.50	1.40	1.40	1.45	1.55	1.75
10	2.30	4.25	5.60	2.95	2.95	2.50	4.10	1.35	1.50	1.50	1.60	1.75
11	2.80	4.35	6.75	2.90	2.95	2.40	3.60	1.35	1.60	1.50	1.55	1.95
12	3.05	4.50	7.60	2.95	3.00	2.30	3.05	1.40	1.55	1.50	1.60	1.65
13	3.10	4.85	8.45	2.95	2.70	2.25	2.70	1.40	1.55	1.55	1.60	1.80
14	3.50	4.55	7.95	2.95	2.65	2.45	2.55	1.35	1.50	1.50	1.60	4.20
15	3.75	3.90	7.05	2.75	2.50	2.25	2.35	1.40	1.50	1.40	1.60	5.20
16	4.10	3.60	5.45	2.45	2.55	2.20	2.20	1.50	1.50	1.50	1.60	4.90
17	4.10	3.40	5.19	2.55	2.55	2.25	2.15	1.45	1.40	2.30	1.60	4.45
18	4.15	3.20	4.60	2.75	2.45	2.25	2.10	1.50	1.50	2.30	1.60	3.95
19	3.80	3.30	4.85	3.35	2.25	2.45	2.15	1.50	1.40	2.45	1.55	3.90
20	3.60	3.20	5.40	4.10	2.15	2.80	1.95	1.50	1.45	2.35	1.55	3.90
21	3.35	3.10	5.10	4.35	2.15	3.55	1.85	1.50	1.50	2.25	1.55	3.95
22	3.25	3.00	4.90	4.05	2.20	3.65	1.75	1.55	1.45	2.15	1.60	3.85
23	3.25	3.10	4.65	4.20	2.10	3.55	1.80	1.60	1.40	2.10	1.60	3.60
24	3.20	3.45	4.85	4.60	2.25	3.15	1.95	1.55	1.40	1.85	1.65	3.00
25	3.10	3.15	4.90	4.60	2.25	3.20	1.95	1.60	1.40	1.75	1.60	2.80
26	3.10	3.10	4.35	4.35	2.50	3.80	1.95	1.70	1.50	1.80	1.65	2.70
27	3.15	3.05	4.00	4.15	2.90	4.15	1.95	1.70	1.50	1.80	1.65	2.75
28	3.15	3.10	3.95	3.90	4.00	4.15	1.85	1.65	1.50	1.75	1.60	2.75
29	2.85	.....	3.65	3.55	6.00	4.05	1.70	1.60	1.50	1.75	1.65	2.65
30	2.75	.....	3.40	3.35	7.50	3.75	1.65	1.70	1.50	1.85	1.60	2.70
31	2.45	.....	3.35	.....	6.90	.....	1.60	1.65	.....	1.95	.....	2.75

SANDUSKY RIVER AT FREMONT, OHIO.

This station was established November 18, 1898, by H. A. Pressey and B. H. Flynn at the bridge of the Lake Shore Railroad at Fremont. It is described in Water-Supply Paper No. 49, page 221. Owing to changes made in a neighboring dam and the reconstruction of the bridge at the station which materially affected the value of the gage record, observations were discontinued on March 10, 1901. A discharge measurement was made by B. H. Flynn on April 23, 1901, at a gage height of 1.90 feet, the discharge being 1,665 second-feet. A measurement was also made by him on April 25 of the Sandusky River at Mexico, Ohio, where formerly a gaging station was maintained, and the discharge found to be 664 second-feet for a gage height of 2.95 feet.

Daily gage height, in feet, of Sandusky River, at Fremont, Ohio, for 1901.

Day.	Jan.	Feb.	Mar.	Day.	Jan.	Feb.	Mar.
1	0.95	0.90	0.55	17	1.70	0.80	.....
2	.90	1.00	.60	18	1.80	.70	.....
3	.95	1.30	.70	19	1.70	.75	.....
4	.80	1.10	1.00	20	1.60	.70	.....
5	.90	.90	1.60	21	1.45	.80	.....
6	.95	1.10	2.15	22	1.30	.70	.....
7	1.00	1.20	2.15	23	1.30	.70	.....
8	1.10	1.20	2.10	24	1.20	.70	.....
9	1.05	1.10	2.80	25	1.30	.65	.....
10	1.15	1.10	.....	26	1.25	.65	.....
11	1.25	1.00	.....	27	1.20	.55	.....
12	1.30	.90	.....	28	1.10	.60	.....
13	1.30	1.00	.....	29	1.00	.....	.....
14	1.40	1.00	.....	30	1.00	.....	.....
15	1.55	.90	.....	31	.90	.....	.....
16	1.65	1.00	.....				

GRAND RIVER AT NORTH LANSING, MICH.

A gaging station was established at Schuyler street bridge, North Lansing, March 2, 1901. The gage was erected by Prof. H. K. Vedder, C. E., of the Michigan Agricultural College. It is attached vertically to the upstream side of the center pier of the bridge. The gage is a cypress board divided decimally from 0 to 11 feet. Observations of the gage are taken twice daily by Thomas Costigan. Schuyler street bridge is located one-eighth mile downstream from North Lansing dam, and the water surface is never frozen underneath the bridge. The current is smooth and fairly uniform, and is confined in a narrow channel at all stages.

Above North Lansing dam the stream becomes frozen at times to a depth of from 1 to 2 feet below the surface, and the winter flow is relatively small, owing to freezing up of the channel and tributaries. The drainage area above the North Lansing gaging station is estimated at 1,238 square miles.

Daily gage height, in feet, of Grand River at North Lansing, Mich., for 1901.

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	5.49	2.58	2.17	2.40	3.11	2.39	2.00	1.75	2.32
2	.....	5.17	2.58	2.32	2.45	2.80	2.41	1.65	1.75	2.20
3	2.05	4.93	2.39	2.15	2.25	2.75	2.85	1.60	1.22	2.20
4	2.35	4.57	2.27	1.87	2.20	2.30	3.15	1.65	1.55	2.22
5	2.55	4.38	2.22	1.74	4.74	3.26	2.75	1.45	1.65	2.12
6	2.75	4.22	2.03	1.69	6.84	2.81	2.78	1.51	1.65	2.20
7	2.65	4.31	2.05	1.64	6.30	2.50	2.64	1.35	1.70	2.12
8	2.50	4.16	2.09	1.55	5.55	2.55	2.50	1.37	1.57	2.12
9	2.50	4.06	2.70	1.52	4.75	2.65	2.40	1.32	1.45	2.25
10	3.10	3.90	3.41	1.48	4.16	2.45	2.10	1.34	1.37	2.60
11	3.90	3.57	3.56	1.70	3.50	2.40	2.17	1.55	2.05	3.35
12	4.56	3.40	3.48	1.40	3.06	2.91	2.57	1.37	2.25	3.45
13	4.85	3.35	2.04	1.68	2.70	2.76	2.95	3.90	2.32	3.67
14	5.55	3.24	2.69	2.30	2.55	2.72	2.60	4.90	2.70	4.15
15	3.05	3.13	2.35	2.02	2.55	2.39	1.70	4.85	2.70	4.45
16	6.20	3.02	2.20	2.15	2.50	2.52	2.40	4.60	2.81	4.70
17	6.12	3.04	2.02	1.98	2.15	2.15	2.20	4.10	2.45	4.70
18	7.04	3.23	1.79	1.60	2.28	2.22	2.05	3.45	2.67	4.70
19	9.23	3.74	1.97	1.85	2.52	2.70	1.65	3.20	2.72	4.55
20	10.94	3.75	1.93	1.65	2.45	2.50	2.07	2.90	2.61	4.25
21	10.99	3.64	1.74	1.56	2.31	2.40	2.17	2.77	2.80	3.90
22	10.12	4.14	1.84	1.57	2.41	2.57	2.05	2.57	2.55	3.51
23	9.52	4.72	1.85	1.65	2.56	2.77	2.27	2.51	2.25	3.10
24	9.80	4.84	2.20	1.49	2.40	2.80	2.12	2.20	2.10	2.75
25	9.12	4.66	2.74	1.57	2.05	2.69	1.95	2.40	1.95	2.45
26	9.33	4.34	2.92	2.09	1.95	2.85	2.00	2.15	2.05	2.65
27	8.93	3.90	2.93	2.68	2.95	2.81	1.95	1.87	2.82	2.50
28	7.97	3.49	2.73	2.75	3.13	3.10	2.02	1.90	2.25	2.75
29	7.19	3.19	2.63	2.63	3.17	3.06	1.45	1.80	2.55	3.00
30	6.45	2.95	2.23	2.50	3.17	3.25	2.10	1.90	2.00	3.15
31	5.93	.....	2.72	.....	2.99	3.15	.....	1.72	.....	3.22

GRAND RIVER AT GRAND RAPIDS, MICH.

A gaging station was established at Fulton street, Grand Rapids, March 12, 1901, and records of the river stage have been maintained at that point throughout the year. Observations are taken each morning and evening by James A. Duncan. A gage was also erected in the channel of Grand River at Cherry street, Grand Rapids, March 25, 1901. Observations were taken twice daily by James A. Duncan, March 25 to April 30, 1901, inclusive.

A gaging station was established at Wealthy avenue, Grand Rapids, May 1, 1901, and observations twice each day have been taken from May 1 throughout the year by James A. Duncan.

The records obtained at the Cherry street and Wealthy avenue stations are here published in one table.

Another gage was established at the Sixth street bridge, where readings were taken twice daily by James A. Duncan from March 11 to September 21, 1901.

The above-named gaging stations on Grand River in the city of Grand Rapids were established in cooperation with L. W. Anderson, city engineer, under whose direction the gages were erected and the records kept. In addition, numerous current-meter measurements have been made by Mr. Anderson, the results of which are not at present available.

Daily gage height, in feet, of Grand River at Fulton street, Grand Rapids, Mich., for 1901.

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	9.82	1.73	0.68	0.35	0.70	0.85	−0.31	0.15	0.00
2	.....	8.55	1.53	.49	.13	.64	.59	− .27	.13	.18
3	.....	7.45	1.27	.47	.14	.42	.37	− .21	.06	.12
4	.....	6.43	1.06	.47	− .17	.17	.24	− .31	.15	.04
5	.....	5.47	.92	.38	+4.63	.35	.10	− .38	.10	− .12
6	.....	4.70	.74	.37	6.56	− .16	− .04	− .53	.10	− .35
7	.....	4.20	.58	.23	6.72	+ .06	− .11	− .35	.05	− .39
8	.....	3.87	.79	.10	6.41	.00	− .24	− .41	.08	− .37
9	.....	3.45	.96	− .10	5.74	− .06	− .29	.41	.01	+ .09
10	.....	3.11	1.23	− .02	4.80	− .09	.28	− .43	− .09	.11
11	.....	2.84	1.41	+ .23	3.80	.59	− .17	− .35	+ .04	.14
12	1.78	2.49	1.71	.25	2.88	− .12	+ .21	.22	.17	.21
13	2.29	2.14	1.69	.46	2.24	− .17	.35	+ .31	.29	.42
14	3.18	2.03	1.47	.71	1.60	.26	.14	.90	.25	1.07
15	3.95	1.74	1.32	1.13	1.28	− .32	.30	1.42	.26	.52
16	4.25	1.60	1.05	.99	.97	.38	.37	2.01	.23	.52
17	4.35	1.57	.83	1.04	.75	− .44	.31	1.78	.07	1.98
18	5.12	1.76	.62	.85	.68	− .65	.18	1.65	.17	2.10
19	6.83	2.06	.52	.70	.59	− .39	.03	1.39	.12	2.17
20	8.54	2.25	.48	.58	.42	+ .26	.01	1.12	.12	2.30
21	9.23	2.27	.44	.43	.18	.18	− .06	1.00	.09	2.10
22	9.93	2.20	.48	.24	.29	.02	− .21	.77	.03	2.45
23	10.77	2.29	.65	.09	.20	.12	− .03	.70	.08	2.46
24	10.97	2.68	.67	.08	.17	.09	− .16	.71	.06	2.32
25	11.76	2.96	.81	.18	.19	.00	− .22	.59	.20	2.26
26	12.59	2.94	1.04	.04	.44	.22	− .21	.46	.19	2.06
27	13.45	3.05	1.16	.08	.68	.16	− .20	.21	.17	1.27
28	13.87	2.53	1.09	− .11	.57	.16	− .26	.40	.04	1.09
29	13.33	2.27	.99	− .02	.94	.08	− .40	.28	.22	.75
30	12.31	1.93	.90	+ .26	.92	.12	− .26	.25	.15	1.44
31	11.04	.....	.75	.....	.94	.29	.....	.24	.....	.58

Daily gage height, in feet, of channel of Grand River at Cherry street and Wealthy avenue, Grand Rapids, Mich., for 1901.

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	16.96	8.68	7.33	6.90	7.38	7.41	5.79	6.61	6.43
2	.....	15.71	8.51	7.28	6.68	7.20	7.15	5.85	6.51	6.51
3	.....	14.61	8.20	7.23	6.58	6.95	6.78	5.88	6.43	6.52
4	.....	13.59	8.00	7.21	6.26	6.65	6.00	5.88	6.55	6.34
5	.....	12.57	7.80	7.11	11.36	6.80	6.48	5.70	6.54	6.19
6	.....	11.81	7.57	7.10	13.11	6.41	6.28	5.54	6.46	6.15
7	.....	11.46	7.42	6.81	13.25	6.30	6.16	5.62	6.44	5.97
8	.....	11.07	7.55	7.82	13.22	6.31	5.96	5.57	6.45	5.70
9	.....	10.50	7.85	6.43	12.78	6.27	5.95	5.65	6.44	6.38
10	.....	10.16	8.41	6.44	11.80	6.11	5.96	5.55	6.17	6.59
11	.....	9.86	8.32	6.78	10.75	5.45	6.21	5.70	6.40	6.64
12	.....	9.52	8.62	6.84	9.80	5.97	6.30	6.08	6.53	6.72
13	.....	9.21	8.65	7.12	9.11	5.97	6.81	6.80	6.50	7.01
14	.....	9.02	8.41	7.42	8.41	5.91	6.65	7.51	6.73	7.81
15	.....	8.73	8.24	7.89	8.00	5.73	6.84	8.08	6.72	7.25
16	.....	8.55	7.96	7.75	7.71	5.71	6.89	8.73	6.70	8.67
17	.....	8.54	7.65	7.82	7.40	5.65	6.68	8.55	6.54	9.07
18	.....	8.71	7.47	7.63	7.32	5.40	6.50	8.37	6.59	9.32
19	.....	9.05	7.35	7.41	7.25	5.70	6.19	8.12	6.60	9.49
20	.....	9.26	7.28	7.23	7.06	6.80	6.27	7.76	6.50	9.51
21	.....	9.27	7.27	7.01	6.72	6.67	6.26	7.66	6.59	9.31
22	.....	9.19	7.27	6.83	6.89	6.41	6.04	7.45	6.46	9.20
23	.....	9.27	7.43	6.64	6.59	6.50	6.07	7.32	6.53	9.36
24	.....	9.70	7.50	6.59	6.57	6.43	5.73	7.32	6.54	9.11
25	18.77	10.00	7.56	6.67	6.64	6.35	6.01	7.19	6.74	8.85
26	19.64	9.98	7.88	6.39	7.01	6.57	5.95	7.01	6.68	8.57
27	20.48	9.78	7.03	6.50	7.32	6.41	5.90	6.72	6.65	8.30
28	20.90	9.54	7.96	6.36	7.21	6.49	5.92	6.87	6.51	8.00
29	20.35	9.23	7.85	6.39	7.60	6.40	5.68	6.63	6.66	7.74
30	19.38	8.90	7.65	6.85	7.65	6.49	5.83	6.64	6.61	7.71
31	18.21	.....	7.53	.....	7.58	6.63	.....	6.69	.....	7.54

Daily gage height, in feet, of Grand River at Sixth street, Grand Rapids, Mich., for 1901.

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	.....	17.77	15.38	15.05	13.89	14.46	15.17
2	.....	17.38	15.30	15.43	13.61	13.95	14.68
3	.....	17.06	15.23	14.86	13.35	13.89	14.28
4	.....	16.72	15.11	14.75	14.86	15.12	14.24
5	.....	16.47	15.48	14.49	16.72	14.12	13.92
6	.....	16.30	15.02	14.12	16.99	13.60	13.18
7	.....	16.37	15.00	13.81	16.98	12.91	13.20
8	.....	16.08	14.94	14.04	16.76	12.84	14.51
9	.....	15.92	15.04	15.26	16.48	12.71	12.94
10	.....	15.84	15.14	13.56	16.24	12.41	13.16
11	14.95	15.73	15.24	13.57	15.96	14.67	13.73
12	15.28	15.65	15.74	14.02	15.39	12.80	13.71
13	15.75	15.50	15.42	14.62	15.53	12.85	13.84
14	16.03	15.88	15.23	15.02	15.65	72.07	13.78
15	16.18	15.44	15.12	15.22	15.15	12.00	14.20
16	16.39	15.33	15.08	15.52	14.95	12.55	13.90
17	16.48	15.40	15.08	15.09	14.84	12.60	13.92
18	16.47	15.55	15.11	14.70	14.53	13.19	13.79
19	17.04	15.59	15.43	14.50	14.36	12.71	14.31
20	17.33	15.56	14.98	14.00	14.38	14.71	13.46
21	17.56	15.89	14.91	13.89	15.20	14.47	13.95
22	17.84	15.60	14.92	13.55	13.62	13.47	.....
23	18.13	15.56	14.96	15.11	13.19	14.17	.....
24	18.32	15.72	15.04	13.57	13.35	14.14	.....
25	15.58	15.79	15.17	13.41	13.19	14.62	.....
26	18.93	15.79	15.63	13.19	14.18	13.55	.....
27	19.40	15.76	15.34	12.65	14.66	13.49	.....
28	19.55	16.00	15.23	12.31	15.29	13.74	.....
29	19.20	15.61	15.16	12.65	14.71	13.81	.....
30	18.74	15.46	15.19	15.01	14.89	13.91	.....
31	18.28	.....	15.06	.....	14.76	14.65	.....

RATING TABLES.

Rating tables for stations in New Hampshire, Connecticut, New Jersey, Pennsylvania, Maryland, and West Virginia.

[Discharge in second-feet.]

Gage height, in feet.	Connecticut River at Orford, N. H.	Housatonic River at Gaylordsville, Conn.	Passaic River, at Two Bridges, N. J.	Pompton River at Two Bridges, N. J.	Delaware River at Lambertville, N. J.	North Branch of the Susquehanna River at Danville, Pa.	Juniata River at Newport, Pa.	Susquehanaa River at Harrisburg, Pa.	Patapsco River at Woodstock, Md.	North Branch of the Potomac River at Piedmont, W. Va.	South Branch of Potomac River near Springfield, W. Va.	Antietam Creek near Sharpsburg, Md.
0.0								2,500				
0.2								3,230				
0.4								4,020				
0.6								4,820				
0.8								5,720				
1.0				195				6,990				
1.2				255				8,150				38
1.4				365				9,450				60
1.6				505		825		10,750				95
1.8			137	645		1,100		12,300		34		154
2.0			225	785		1,400		13,900		77		217
2.2			317	929		1,800		15,500		124		281
2.4	965		409	1,073	1,750	2,250		17,300		175		348
2.6	1,045		503	1,218	2,100	2,750	350	19,300		230		416
2.8	1,125	240	599	1,364	2,600	3,300	600	21,300		289		485
3.0	1,205	324	695	1,510	3,300	3,900	1,000	23,400	50	352	250	560
3.2	1,291	411	791	1,656	4,100	4,550	1,400	25,625	83	430	285	665
3.4	1,393	508	887	1,802	5,050	5,250	1,820	27,925	122	525	335	775
3.6	1,515	620	983	1,948	6,100	6,000	2,270	30,300	173	640	400	887
3.8	1,653	745	1,079	2,094	7,250	6,800	2,750	32,800	235	775	490	1,001
4.0	1,800	885	1,175	2,240	8,550	7,650	3,250	35,400	310	920	600	1,215
4.2	1,952	1,065	1,275	2,386	10,000	8,575	3,750	38,100	400	1,080	730	1,329
4.4	2,108	1,285	1,375	2,532	11,650	9,525	4,300	41,100	520	1,240	890	1,443
4.6	2,263	1,545	1,475	2,678	13,350	10,500	4,900	44,590	670	1,400	1,070	1,557
4.8	2,432	1,865	1,575	2,824	15,050	11,500	5,500	48,170	830	1,560	1,250	1,671
5.0	2,600	2,215	1,675	2,970	16,750	12,550	6,200	51,750	1,000	1,720	1,430	1,785
5.2	2,772	2,600	1,775	6,116	18,500	13,720	6,900	55,330	1,200	1,880	1,610	1,899
5.4	2,948	3,005	1,875	3,262	20,300	14,900	7,700	58,910	1,400	2,040	1,790	2,013
5.6	3,128	3,435	1,975	3,408	22,150	16,100	8,500	62,490	1,600	2,200	1,970	2,127
5.8	3,312	3,890	2,075	3,554	24,050	17,390	9,350	66,070	1,800	2,360	2,150	2,241
6.0	3,500	4,365	2,175	3,700	25,950	18,800	10,250	69,650	2,000	2,520	2,330	2,355
6.2	3,692	4,845	2,277	3,846	27,850	20,240	11,150	73,230	2,205	2,680	2,510	
6.4	3,888	5,325	2,379	3,992	29,750	21,680	12,060	76,810	2,410	2,840	2,690	
6.6	4,088	5,805	2,481	4,138	31,700	23,120	13,000	80,390	2,615	3,000	2,870	
6.8	4,292	6,285	2,583	4,284	33,710	24,560	14,000	83,970	2,820	3,160	3,050	
7.0	4,500	6,765	2,685	4,430	35,750	26,000	15,000	87,550	3,025	3,320	3,230	
7.2	4,712	7,245	2,787	4,576	37,810	27,440	16,000	91,130	3,229	3,480	3,410	
7.4	4,928	7,725	2,889	4,722	39,870	28,880	17,000	94,710	3,435	3,640	3,600	
7.6	5,148	8,205	2,981	4,868	41,930	30,320	18,000	98,290	3,640	3,800	3,705	
7.8	5,372	8,685	3,083	5,014	43,990	31,760	19,000	101,870	3,844	3,960	3,795	
8.0	5,600	9,165	3,195	5,160	46,050	33,200	20,000	105,450	4,050	4,120	3,885	
8.5	6,184	10,365	3,450	5,525	51,200	36,800	22,500	114,400	4,562	4,520	4,110	
9.0	6,780	11,565	3,705		56,350	40,400	25,000	123,350	5,075	4,920	4,335	
9.5	7,385	12,765	3,960		61,500	44,000	27,500	132,300	5,588		4,560	
10.0	7,990	13,965	4,215			47,600	30,000	141,250	6,100		4,785	
10.5	8,595	15,165				51,200	32,500	150,200	6,612		5,010	
11.0	9,200	16,365				54,800	35,000	159,150	7,125		5,235	
11.5	9,805	17,565				58,400	37,500	168,100	7,638		5,460	
12.0	10,410					62,000	40,000	177,050	8,150		5,685	
12.5	11,015					65,600	42,500	186,000			5,910	
13.0	11,620					69,200	45,000	194,950			6,135	
13.5	12,225					72,800	47,500	203,900			6,360	
14.0	12,830					76,400	50,000	212,850			6,585	
14.5	13,435					80,000	52,500	221,800			6,810	
15.0	14,040					83,600	55,000	230,750			7,035	
15.5	14,645					87,200	57,500	239,700			7,260	
16.0	15,250					90,800	60,000	248,650			7,485	
16.5	15,855					94,400	62,500	257,600			7,710	
17.0	16,460					98,000	65,000	266,550			7,935	
17.5	17,065					101,600	67,500	275,500			8,160	
18.0	17,670					105,200	70,000	284,450			8,385	
18.5	18,275					108,800		293,400			8,610	
19.0	18,880					112,400		302,350			8,835	
19.5	19,485					116,000		311,300			9,060	
20.0	20,090					119,600		320,250			9,285	
20.5	20,695					123,200		329,200			9,510	
21.0	21,300					126,800		338,150			9,735	
21.5	21,905					130,400		347,100			9,960	
22.0	22,510					134,000					10,185	

Rating tables for stations in Maryland, Virginia, and West Virginia.

[Discharge in second-feet.]

Gage heights in feet.	North Branch of Shenandoah River, near Riverton, Va.	South Branch of Shenandoah River at Front Royal, Va.	Shenandoah River at Millville, W. Va.	Potomac River at Point of Rocks, Md.	Monocacy River, near Frederick, Md.	North (of James) River at Glasgow, Va.	James River at Buchanan, Va.	James River at Cartersville, Va.	Appomattox River at Mattoax, Va.	Staunton River at Randolph, Va.	Dan River at South Boston, Va.	Roanoke River at Roanoke, Va.
.20				1,000								
.40			540	1,400				702		1,145	750	55
.60			740	1,860				1,000		1,205	850	85
.8			940	2,360		280		1,296	171	1,270	950	120
1.0			1,140	2,900		350		1,600	195	1,350	1,050	170
1.2			1,370	3,600		450		1,916	219	1,430	1,150	240
1.4			1,650	4,300		580		2,243	243	1,515	1,250	325
1.6			1,950	5,100		720	310	2,582	267	1,615	1,360	429
1.8			2,260	6,020		890	360	2,932	291	1,730	1,480	554
2.0			2,600	7,000		1,090	430	3,294	318	1,850	1,600	688
2.2			2,960	7,980		1,296	540	3,672	351	1,990	1,730	888
2.4			3,340	8,960		1,525	670	4,063	387	2,130	1,860	1,156
2.6			3,740	9,940		1,795	840	4,463	424	2,270	2,000	1,424
2.8			4,160	10,920		2,100	1,050	4,871	462	2,410	2,150	1,692
3.0			4,600	11,900		2,425	1,330	5,300	500	2,550	2,300	1,960
3.2			5,060	13,040		2,757	1,650	5,740	540	2,690	2,450	2,228
3.4			5,540	14,240		3,092	1,980	6,190	580	2,830	2,600	2,496
3.6	140		6,050	15,460	45	3,430	2,330	6,650	625	2,980	2,760	2,764
3.8	240		6,600	16,680	90	3,776	2,690	7,120	675	3,140	2,930	3,032
4.0	380	360	7,190	17,900	150	4,130	3,050	7,600	725	3,300	3,100	3,300
4.2	580	470	7,790	19,120	210	4,492	3,440	8,100	775	3,460	3,280	3,568
4.4	805	605	8,410	20,340	270	4,862	3,840	8,610	825	3,620	3,460	3,836
4.6	1,035	750	9,040	21,560	340	5,239	4,240	9,130	880	3,780	3,640	4,164
4.8	1,265	915	9,680	22,780	420	5,628	4,640	9,660	940	3,940	3,820	4,372
5.0	1,495	1,100	10,320	24,000	500	6,030	5,060	10,200	1,000	4,100	4,000	4,640
5.2	1,725	1,300	10,960	25,220	600	6,438	5,490	10,760	1,080	4,270	4,200	4,912
5.4	1,955	1,520	11,600	26,440	700	6,846	5,950	11,330	1,160	4,450	4,400	5,184
5.6	2,185	1,760	12,240	27,660	800	7,254	6,425	11,910	1,240	4,640	4,600	5,456
5.8	2,415	2,050	12,880	28,880	900	7,662	6,911	12,500	1,320	4,840	4,800	5,728
6.0	2,645	2,380	13,520	30,100	1,020	8,070	7,403	13,100	1,400	5,050	5,000	6,000
6.2	2,875	2,740	14,160	31,400	1,192	8,480	7,903	13,760	1,480	5,260	5,200	6,272
6.4	3,105	3,100	14,800	32,700	1,364	8,890	8,411	14,420	1,560	5,480	5,400	6,544
6.6	3,335	3,460	15,440	34,100	1,536	9,300	8,927	15,080	1,640	5,700	5,600	6,826
6.8	3,565	3,820	16,080	35,500	1,708	9,710	9,452	15,740	1,720	5,920	5,800	7,098
7.0	3,795	4,180	16,720	36,950	1,880	10,120	9,980	16,400	1,800	6,150	6,000	7,360
7.2	4,025	4,540	17,360	38,450	2,052	10,530	10,508	17,060	1,880	6,380	6,200	7,632
7.4	4,255	4,900	18,000	40,000	2,224	10,940	11,036	17,720	1,960	6,610	6,400	7,904
7.6	4,485	5,260	18,640	41,600	2,396	11,350	11,564	18,380	2,040	6,840	6,600	8,176
7.8	4,715	5,620	19,280	43,200	2,568	11,760	12,092	19,040	2,120	7,070	6,800	8,448
8.0	4,945	5,980	19,920	44,900	2,740	12,170	12,620	19,700	2,200	7,300	7,000	8,720
8.5	5,520	6,880	21,520	49,300	3,170	13,195	13,940	21,350	2,450	7,900	7,550	9,400
9.0	6,095	7,780	23,120	53,850	3,600	14,220	15,260	23,000	2,700	8,500	8,100	10,080
9.5	6,670	8,680	24,720	58,400	4,030	15,245	16,580	24,650	2,975	9,125	8,700	10,760
10.0	7,245	9,580	26,320	62,950	4,460	16,270	17,900	26,300	3,250	9,750	9,300	11,440
10.5	7,820	10,480	27,920	67,500	4,890	17,295	19,220	27,950	3,550	10,400	9,900	12,120
11.0	8,395	11,380	29,520	72,050	5,320	18,320	20,540	29,600	3,850	11,050	10,500	12,800
11.5	8,970	12,280		76,600	5,750	19,345	21,860	31,250	4,150	11,750	11,100	13,480
12.0	9,545	13,180		81,150	6,180	20,370	23,180	32,900	4,450	12,500	11,700	14,160
12.5	10,120	14,080		85,700	6,610	21,395	24,500	34,550	4,750	13,250	12,400	14,840
13.0	10,695	14,980		90,250	7,040	22,420	25,820	36,200	5,050	14,000	13,100	15,520
13.5	11,270	15,880		94,800	7,470	23,445	27,140	37,850	5,350	14,850	14,000	16,200
14.0	11,845	16,780		99,350	7,900	24,470	28,460	39,500	5,650	15,750	14,900	16,880
14.5	12,420	17,680		103,900	8,330		29,780	41,150	5,950	16,650	15,950	17,560
15.0	12,995	18,580		108,450	8,760		31,100	42,800	6,250	17,600	17,000	18,240
15.5	13,570	19,490		113,000	9,190		32,420	44,450	6,550	18,625	18,200	
16.0	14,145	20,380		117,550	9,620		33,740	46,100	6,850	19,650	19,400	
16.5	14,720	21,280		122,100	10,050		35,060	47,750	7,150	20,725	20,750	
17.0	15,295	22,180		126,650	10,480		36,380	49,400	7,450	21,800	22,100	
17.5	15,870	23,080		131,200	10,910		37,700	51,050	7,750	22,975	23,550	
18.0		23,980		135,750	11,340		39,020	52,700	8,050	24,150	25,000	
18.5		24,880		140,300	11,770		40,340	54,350	8,350	25,400	26,600	
19.0		25,780		144,850	12,200		41,660	56,000	8,650	26,650	28,200	
19.5		26,680		149,400	13,060		42,980	57,650	8,950	27,975	30,000	
20.0		27,580		153,950			44,300	59,300	9,250	29,300	31,800	
20.5				158,500			45,620	60,950	9,550	30,700	33,800	
21.0				163,050			46,940	62,600	9,850	32,100	35,800	
21.5				167,600			48,260	64,250	10,150	33,575	37,800	
22.0				172,150			49,580	65,900	10,450	35,050	39,800	
22.5							50,900	67,550	10,750	36,600	41,800	
23.0								69,200	11,050	38,150	43,800	
24.0								72,500	11,650	41,500	47,800	
25.0								75,800	12,250	45,100	51,800	

Rating tables for stations in North Carolina, South Carolina, and Georgia.

[Discharge in second-feet.]

Gage height, in feet.	Roanoke River at Neal, N. C.	Deep River at Cumnock, N. C.	Cape Fear River at Fayetteville, N. C.	Yadkin River at Salisbury, N. C.	Catawba River at Catawba, N. C.	Catawba River, near Rockhill, S. C.	Broad River (of the Carolinas), near Alston, S. C.	Saluda River at Waterloo, S. C.	Tallulah River at Tallulah Falls, Ga.	Tugaloo River near Madison, S. C.	Savannah River near Calhoun Falls, S. C.	Savannah River at Augusta, Ga.
0.0	1,320	...	...	...	...	...	...	...	...	...	...	...
0.2	1,440	...	...	...	...	...	...	...	...	...	...	...
0.4	1,560	...	...	...	...	...	...	...	...	...	...	...
0.6	1,680	...	...	...	...	...	...	...	...	...	...	...
0.8	1,800	70	440	...	...	...	...	...	...	...	...	...
1.0	1,920	80	500	...	...	...	...	...	...	...	...	...
1.2	2,050	100	560	...	...	...	...	...	380	705	...	...
1.4	2,180	126	620	...	...	...	...	...	429	775	...	...
1.6	2,310	160	680	...	...	...	...	...	498	845	...	...
1.8	3,440	203	740	...	...	3,505	...	...	587	920	...	...
2.0	2,580	250	800	...	2,000	3,825	...	...	700	1,000	1,760	...
2.2	2,720	298	880	2,120	2,180	4,145	...	...	840	1,090	1,990	...
2.4	2,860	346	960	2,750	2,360	4,465	...	...	980	1,180	2,280	...
2.6	3,000	394	1,040	3,460	2,540	4,850	...	...	1,120	1,275	2,690	...
2.8	3,140	442	1,120	4,180	2,720	5,300	...	...	1,260	1,375	3,150	...
3.0	3,280	490	1,200	4,900	2,900	5,750	3,000	...	1,400	1,475	3,900	...
3.2	3,420	550	1,280	5,640	3,100	6,250	3,340	...	1,540	1,580	4,770	...
3.4	3,560	620	1,360	6,380	3,300	6,750	3,680	...	1,680	1,690	5,640	...
3.6	3,700	700	1,440	7,130	3,500	7,250	4,020	...	1,820	1,800	6,510	...
3.8	3,840	780	1,520	7,890	3,700	7,750	4,360	...	1,960	1,920	7,380	...
4.0	3,980	860	1,600	8,650	3,900	8,250	4,730	630	2,100	2,060	8,250	2,350
4.2	4,120	940	1,680	9,430	4,120	8,850	5,200	722	2,240	2,220	9,120	2,470
4.4	4,260	1,020	1,760	10,210	4,340	9,450	5,760	843	2,380	2,380	9,990	2,695
4.6	4,400	1,100	1,840	11,000	4,560	10,100	6,320	978	2,520	2,540	10,860	2,725
4.8	4,540	1,200	1,920	11,800	4,780	10,800	6,900	1,114	2,660	2,700	11,735	2,860
5.0	4,680	1,300	2,000	12,600	5,000	11,500	7,500	1,250	2,800	2,860	12,600	3,000
5.2	4,830	1,420	2,080	13,420	5,240	12,200	8,100	1,386	2,940	3,020	13,470	3,160
5.4	4,980	1,540	2,160	14,240	5,480	12,900	8,700	1,522	3,080	3,180	14,340	3,340
5.6	5,130	1,680	2,240	15,070	5,720	13,650	9,300	1,658	3,220	3,340	15,210	3,540
5.8	5,280	1,830	2,320	15,910	5,960	14,450	9,900	1,794	3,360	3,500	16,080	3,760
6.0	5,430	1,990	2,400	16,750	6,200	15,250	10,500	1,930	3,500	3,660	16,950	4,000
6.2	5,590	2,150	2,480	17,610	6,460	16,050	11,100	2,066	3,640	3,820	17,820	4,240
6.4	5,750	2,310	2,560	18,470	6,720	16,850	11,700	2,202	3,780	3,980	18,690	4,490
6.6	5,910	2,470	2,640	19,340	6,980	17,700	12,300	2,338	3,920	4,140	19,560	4,750
6.8	6,070	2,630	2,720	20,220	7,240	18,600	12,900	2,474	4,060	4,300	20,430	5,020
7.0	6,230	2,790	2,800	21,100	7,500	19,500	13,500	2,610	4,200	4,460	21,300	5,300
7.2	6,424	2,950	2,880	22,000	7,800	20,400	14,100	2,746	4,340	4,620	22,170	5,600
7.4	6,618	3,110	2,960	22,900	8,100	21,300	14,700	2,882	4,480	4,780	23,040	5,[illegible]
7.6	6,812	3,270	3,050	23,810	8,400	22,200	15,300	3,018	4,620	4,940	23,910	6,200
7.8	7,006	3,430	3,150	24,730	8,700	23,100	15,900	3,154	4,760	5,100	24,780	6,500
8.0	7,200	3,590	3,250	25,650	9,000	24,000	16,500	3,290	4,900	5,260	25,650	6,800
8.5	7,700	3,990	3,500	28,000	9,950	26,500	18,000	3,630	5,250	5,660	27,825	7,600
9.0	8,200	4,390	3,750	30,400	10,900	29,000	19,500	3,970	5,600	6,060	30,000	8,400
9.5	8,730	4,790	4,000	33,000	12,050	31,500	21,000	4,310	5,950	6,[illegible]	32,175	9,250
10.0	9,280	5,190	4,250	35,750	13,200	34,000	22,500	4,650	6,300	6,860	34,350	10,100
10.5	9,830	5,595	4,500	38,650	14,450	36,750	24,250	4,990	...	7,260	36,525	11,000
11.0	10,380	6,000	4,750	41,700	15,700	39,500	26,250	5,330	...	7,660	38,700	11,900
11.5	10,955	6,413	5,000	44,900	17,100	42,500	28,500	5,670	...	8,060	40,875	12,850
12.0	11,530	6,825	5,250	48,300	18,500	45,500	30,750	6,010	...	[illegible],460	43,050	13,800
12.5	12,130	7,237	5,525	51,900	20,100	49,000	33,000	6,350	...	8,860	45,225	14,800
13.0	12,730	7,650	5,800	55,700	21,700	52,750	35,250	6,690	...	9,260	47,400	15,800
13.5	13,385	8,063	6,075	59,700	23,475	56,500	37,875	7,030	...	9,660	49,575	16,850
14.0	14,030	8,475	6,350	63,700	25,250	60,250	40,500	7,370	...	10,060	51,750	17,900
14.5	14,735	8,888	6,625	67,900	27,125	64,125	43,125	7,710	...	10,460	53,925	19,000
15.0	15,430	9,300	6,900	72,400	29,000	68,000	45,750	8,050	...	10,860	56,100	20,100
15.5	16,190	9,712	7,175	77,150	30,637	72,000	49,125	8,390	...	11,260	58,175	21,250
16.0	16,930	10,125	7,450	82,000	32,750	76,000	52,500	8,730	...	11,660	60,450	22,400
16.5	17,730	10,538	7,725	87,400	34,388	80,250	56,625	9,070	...	12,060	62,625	23,600
17.0	18,530	10,950	8,000	93,000	36,500	84,500	60,750	9,410	...	12,460	64,800	24,800
17.5	19,405	11,375	8,275	99,000	38,137	88,750	65,375	9,750	...	12,860	66,975	26,050
18.0	20,280	11,800	8,550	105,000	40,250	93,000	70,000	10,090	...	13,260	69,150	27,300
19.0	22,130	12,650	9,200	117,400	44,000	102,000	79,250	10,770	...	14,060	...	30,100
20.0	24,230	13,500	9,850	...	47,750	111,000	88,500	11,450	...	14,860	...	33,300
25.0	46,500	17,750	13,350	...	66,500	159,250	134,750	14,850	...	...	...	60,000
30.0	82,000	22,000	18,600	...	85,250	...	...	...	...	...	...	104,000
35.0	...	26,250	26,350	...	...	...	...	...	...	...	...	...
40.0	...	...	35,050	...	...	...	...	...	...	...	...	...
45.0	...	...	43,800	...	...	...	...	...	...	...	...	...
50.0	...	...	53,550	...	...	...	...	...	...	...	...	...

Rating tables for stations in Georgia.

[Discharge in second-feet.]

Gage height, in feet.	Broad River (of Georgia) near Carlton, Ga.	Middle Oconee River at Athens, Ga.	Oconee River at Barnett Shoals, Ga.	Apalachee River near Buckhead, Ga.	Oconee River near Dublin, Ga.	Alcovy River near Covington, Ga.	Yellow River at Almon, Ga.	Ocmulgee River near Flovilla, Ga.	Towaliga River near Juliette, Ga.	Ocmulgee River at Macon, Ga.	Flint River at Woodbury, Ga.	Chattahoochee River near Buford, Ga.
0.0											350	
0.2											400	
.4											460	
.6					2,125						530	
.8					2,223						650	
1.0					2,329				120		800	
1.2					2,442				135		1,000	
1.4					2,559	111			154		1,245	
1.6	380				2,680	126			177		1,500	
1.8	450			305	2,805	143			204	1,019	1,780	
2.0	540		780	360	2,934	162			237	1,100	2,060	1,400
2.2	660		870	415	3,067	185	250	680	273	1,184	2,340	1,500
2.4	800		968	470	3,204	212	283	725	309	1,270	2,620	1,630
2.6	940	430	1,074	525	3,345	241	320	870	345	1,359	2,900	1,775
2.8	1,080	499	1,188	580	3,490	273	361	947	381	1,451	3,180	1,925
3.0	1,220	572	1,310	635	3,639	308	406	1,037	417	1,546	3,460	2,075
3.2	1,370	650	1,440	690	3,792	346	455	1,138	453	1,643	3,740	2,225
3.4	1,520	733	1,578	745	3,949	384	511	1,241	489	1,744	4,020	2,380
3.6	1,680	820	1,724	800	4,113	422	577	1,344	525	1,849	4,300	2,540
3.8	1,840	911	1,878	855	4,287	460	652	1,447	561	1,958	4,580	2,700
4.0	2,090	1,006	2,060	910	4,472	498	730	1,550	597	2,070	4,860	2,850
4.2	2,180	1,105	2,233	965	4,670	536	808	1,653	633	2,185	5,140	3,020
4.4	2,360	1,208	2,418	1,020	4,883	574	886	1,756	669	2,304	5,420	3,190
4.6	2,550	1,315	2,615	1,075	5,105	612	964	1,859	705	2,426	5,700	3,360
4.8	2,750	1,426	2,827	1,130	5,332	650	1,042	1,962	741	2,551	5,980	3,530
5.0	2,950	1,541	3,055	1,185	5,560	688	1,120	2,065	777	2,680	6,260	3,710
5.2	3,160	1,661	3,299	1,240	5,788	726	1,198	2,168	813	2,811	6,540	3,900
5.4	3,390	1,786	3,559	1,295	6,016	764	1,276	2,271	849	2,945	6,820	4,100
5.6	3,640	1,915	3,835	1,350	6,244	802	1,354	2,374	885	3,081	7,100	4,300
5.8	3,900	2,050	4,130	1,405	6,472	840	1,432	2,477	921	3,219	7,380	4,500
6.0	4,160	2,190	4,445	1,460	6,700	878	1,510	2,580	957	3,360	7,660	4,700
6.2	4,420	2,336	4,780	1,515	6,928	916	1,588	2,683	993	3,502	7,940	4,900
6.4	4,690	2,490	5,135	1,570	7,156	954	1,666	2,786	1,029	3,646	8,220	5,100
6.6	4,960	2,652	5,510	1,625	7,384	992	1,744	2,889	1,065	3,792	8,500	5,300
6.8	5,230	2,822	5,906	1,680	7,612	1,030	1,822	2,992	1,101	3,940	8,780	5,520
7.0	5,500	3,000	6,310	1,735	7,840	1,068	1,900	3,095	1,137	4,090	9,060	5,744
7.2	5,770	3,180	6,714	1,790	8,068	1,106	1,978	3,198	1,173	4,243	9,340	5,968
7.4	6,040	3,360	7,118	1,845	8,296	1,144	2,056	3,301	1,209	4,398	9,620	6,192
7.6	6,310	3,540	7,522	1,900	8,524		2,134	3,404	1,245	4,556	9,900	6,416
7.8	6,580	3,720	7,926	1,955	8,752		2,212	3,507	1,281	4,717	10,180	6,640
8.0	6,850	3,900	8,330	2,010	8,980		2,290	3,610	1,317	4,880	10,460	6,864
8.5	7,525	4,350	9,340	2,147	9,550		2,485	3,867	1,407	5,306	11,160	7,424
9.0	8,200	4,800	10,350	2,285	10,120		2,680	4,125	1,497	5,770	11,860	7,984
9.5	8,875	5,250	11,360	2,422	10,690		2,875	4,383	1,587	6,265	12,560	8,544
10.0	9,550	5,700	12,370	2,560	11,260		3,070	4,640	1,677	6,820	13,260	9,104
10.5	10,225	6,150	13,380	2,697	11,830		3,265	4,897	1,767	7,420		9,664
11.0	10,900	6,600	14,390	2,835	12,400		3,460	5,155	1,857	8,020		10,224
11.5	11,575	7,050	15,400	3,972	12,970		3,655	5,412	1,947	8,645		10,779
12.0	12,250	7,500	16,410	3,110	13,540		3,850	5,670	2,037	9,400		11,334
12.5	12,925	7,950	17,420	3,247	14,110		4,045	5,927	2,127	10,300		11,899
13.0	13,600	8,400	18,430	3,385	14,680		4,240	6,185	2,217	11,240		12,464
13.5	14,275	8,850	19,440	3,522	15,250		4,435	6,442	2,307	12,470		13,214
14.0	14,950	9,360	20,450	3,660	15,820		4,630	6,700	2,397	13,900		13,584
14.5	15,625	9,750	21,460		16,390		4,825	9,958	2,487	16,000		14,144
15.0	16,300	10,200	22,470		16,960		5,020	7,215	2,577	18,100		14,704
15.5	16,975	10,650			17,530		5,215	7,472	2,667	20,200		15,264
16.0	17,650	11,100			18,100		5,410	7,730	2,757	22,300		15,824
16.5		11,550			18,670		5,605	7,987	2,847	24,400		16,384
17.0		12,000			19,240		5,800	8,245	2,937	26,500		16,944
17.5		12,450			19,810			8,502	3,027	28,600		17,504
18.0		12,900			20,380			8,760		30,700		18,064
18.5		13,350			20,950			9,017		32,800		18,624
19.0		13,800			21,520			9,275		34,900		19,184
20.0		14,700			22,660			9,790		39,100		20,304
21.0		15,600			23,800			10,305		43,300		21,424
22.0		16,500			24,940			10,820				22,544
23.0		17,400			26,080			11,335				
24.0								11,850				

Rating tables for stations in Georgia and Alabama.

[Discharge in second-feet.]

Gage height, in feet.	Chattahoochee River at Oakdale, Ga.	Chattahoochee River at West Point, Ga.	Hillabee Creek near Alexander City, Ala.	Big Sandy Creek near Dadeville, Ala.	Tallapoosa River near Susanna, Ala.	Tallapoosa River near Milstead, Ala.	Etowah River at Canton, Ga.	Coosawattee River at Carters, Ga.	Oostanaula River at Resaca, Ga.	Coosa River at Rome, Ga.	Coosa River near Riverside, Ala.	Talladega Creek at Nottingham, Ala.
−0.50	.....	.....	.....	.....	.....	.....	225	.....	.....	.....	.....	.....
−0.40	.....	.....	.....	.....	.....	.....	275	.....	.....	.....	.....	.....
−0.20	.....	.....	.....	.....	.....	.....	385	.....	.....	.....	.....	.....
0.0	.....	.....	.....	.....	.....	.....	515	.....	.....	.....	.....	.....
0.2	.....	.....	.....	.....	.....	.....	665	.....	.....	.....	.....	.....
0.4	.....	.....	.....	.....	.....	.....	820	.....	.....	.....	.....	.....
0.6	.....	.....	.....	45	.....	.....	988	.....	.....	1,730	.....	.....
0.8	.....	.....	.....	67	.....	.....	1,154	.....	.....	1,930	.....	.....
1.0	.....	935	138	115	.....	.....	1,320	.....	460	2,110	2,460	90
1.2	.....	1,000	156	204	.....	.....	1,486	425	500	2,350	2,760	130
1.4	.....	1,180	184	308	1,680	.....	1,652	495	550	2,600	3,100	174
1.6	1,690	1,380	230	412	1,960	1,450	1,818	575	600	2,850	3,500	218
1.8	1,827	1,600	303	516	2,320	1,675	1,984	670	650	3,120	3,940	262
2.0	1,970	1,840	390	620	2,440	1,900	2,150	765	705	3,400	4,400	306
2.2	2,119	2,100	478	724	3,230	2,125	2,316	865	770	3,700	4,900	350
2.4	2,272	2,380	566	828	3,850	2,350	2,482	970	840	4,000	5,430	394
2.6	2,430	2,680	654	932	4,730	2,575	2,648	1,075	920	4,300	5,970	438
2.8	2,593	3,000	742	1,036	5,630	2,800	2,814	1,180	1,000	4,600	6,530	482
3.0	2,760	3,340	830	1,140	6,530	3,025	2,980	1,290	1,100	4,900	7,100	526
3.2	2,934	3,700	918	1,244	7,430	3,250	3,146	1,400	1,220	5,230	7,700	570
3.4	3,116	4,080	1,006	1,348	8,330	3,475	3,312	1,510	1,340	5,580	8,330	614
3.6	3,305	4,480	1,094	1,452	9,230	3,700	3,478	1,625	1,460	5,930	8,970	658
3.8	3,500	4,920	1,182	1,556	10,130	3,925	3,644	1,750	1,580	6,300	9,620	702
4.0	3,702	5,370	1,270	1,660	11,030	4,150	3,810	1,875	1,700	6,700	10,300	746
4.2	3,909	5,880	1,358	1,764	11,930	4,375	3,946	2,010	1,820	7,102	11,000	790
4.4	4,121	6,400	1,446	1,868	12,830	4,600	4,142	2,145	1,940	7,504	11,700	834
4.6	4,344	6,940	1,534	1,972	13,730	4,825	4,308	2,280	2,080	7,906	12,400	878
4.8	4,572	7,490	1,622	2,076	14,630	5,050	4,474	2,415	2,220	8,308	13,100	922
5.0	4,800	8,040	1,710	2,180	15,530	5,275	4,640	2,550	2,360	8,710	13,800	966
5.2	5,028	8,592	1,798	2,284	16,430	5,499	4,806	2,694	2,510	9,112	14,500	1,010
5.4	5,256	9,144	1,886	2,388	17,330	5,724	4,972	2,838	2,690	9,574	15,200	1,054
5.6	5,484	9,696	1,974	2,492	18,230	5,949	5,138	2,982	2,870	9,916	15,900	1,098
5.8	5,712	10,248	2,062	2,596	19,130	6,174	5,304	3,126	3,050	10,318	16,600	1,142
6.0	5,940	10,800	2,150	2,700	20,030	6,400	5,470	3,270	3,230	10,720	17,300	1,186
6.2	6,168	11,352	2,238	2,804	20,920	6,624	5,636	3,414	3,414	11,122	18,060	1,230
6.4	6,396	11,904	2,326	2,908	21,830	6,849	5,802	3,558	3,598	11,524	18,820	1,274
6.6	6,624	12,456	2,414	3,012	22,730	7,044	5,968	3,702	3,782	11,926	19,580	1,318
6.8	6,852	13,008	2,502	3,116	23,630	7,299	6,134	3,846	3,966	12,328	20,340	1,362
7.0	7,080	13,560	2,590	3,220	24,530	7,525	6,300	3,990	4,150	12,730	21,100	1,406
7.2	7,308	14,112	2,678	3,324	26,330	7,749	6,466	4,134	4,334	13,132	21,900	1,450
7.4	7,536	14,664	2,766	3,428	26,330	7,974	6,632	4,278	4,518	13,534	22,700	1,494
7.6	7,764	15,240	2,854	3,532	27,230	8,199	6,798	4,422	4,702	13,936	23,500	1,538
7.8	7,992	15,820	2,942	3,636	28,130	8,424	6,964	4,566	4,886	14,338	24,300	1,582
8.0	8,220	16,400	3,030	3,740	29,030	8,650	7,130	4,710	5,070	14,740	25,100	1,626
8.5	8,790	17,850	3,250	4,000	31,280	9,212	7,545	5,070	5,530	15,745	27,100	1,736
9.0	9,360	19,300	3,470	4,260	33,530	9,775	7,960	5,430	5,990	16,750	29,100	1,846
9.5	9,930	20,750	3,690	4,520	35,780	10,337	8,375	5,790	6,450	17,755	31,100	1,956
10.0	10,500	22,200	3,910	4,780	38,030	10,900	8,790	6,150	6,910	18,760	33,100	2,066
10.5	11,070	23,650	4,130	5,040	40,280	11,462	9,205	6,510	7,370	19,765	35,100	2,176
11.0	11,640	25,100	4,350	5,300	42,530	12,025	9,620	6,870	7,830	20,770	37,100	2,286
11.5	12,210	26,590	.....	5,560	44,780	12,587	10,035	7,230	8,290	21,775	39,100	.....
12.0	12,780	28,800	.....	5,820	47,030	13,150	10,450	7,590	8,750	22,780	41,100	.....
12.5	13,350	31,100	.....	6,080	49,280	13,712	10,865	7,950	9,210	23,785	43,100	.....
13.0	13,920	33,410	.....	6,340	51,530	14,275	11,280	8,310	9,670	24,790	45,100	.....
13.5	14,490	35,710	.....	6,600	53,780	14,837	11,695	8,670	10,130	25,795	47,100	.....
14.0	15,060	38,030	.....	6,860	.....	15,400	12,110	9,030	10,590	26,800	49,100	.....
14.5	15,630	40,350	.....	7,120	.....	15,962	12,525	9,390	11,050	27,805	51,100	.....
15.0	16,200	42,630	.....	7,380	.....	16,525	12,940	9,750	11,510	28,810	53,100	.....
15.5	16,770	44,930	.....	7,640	.....	17,087	13,355	10,110	11,970	29,815	55,100	.....
16.0	17,340	47,230	.....	7,900	.....	17,650	13,770	10,470	12,430	30,820	57,100	.....
16.5	17,910	49,530	.....	.....	.....	18,012	14,185	10,830	12,890	31,825	59,100	.....
17.0	18,480	51,830	.....	.....	.....	18,775	14,600	11,190	13,350	32,830	61,100	.....
17.5	19,050	54,130	.....	.....	.....	19,337	15,015	11,550	13,810	33,835	63,100	.....
18.0	19,620	56,430	.....	.....	.....	19,900	15,430	11,910	14,270	34,840	65,100	.....
19.0	20,760	61,030	.....	.....	.....	21,025	16,260	12,630	15,190	36,850	69,100	.....
20.0	21,900	65,630	.....	.....	.....	22,150	17,090	13,350	16,110	38,860	.....	.....
25.0	27,600	88,630	.....	.....	.....	27,775	.....	.....	20,710	48,910	.....	.....
30.0	.....	.....	.....	.....	.....	33,400	.....	.....	.....	58,960	.....	.....
35.0	.....	.....	.....	.....	.....	39,025	.....	.....	.....	.....	.....	.....

Rating tables for stations in Alabama, Mississippi, Maryland, West Virginia, Virginia, North Carolina, and Tennessee.

[Discharge in second-feet.]

Gage height, in feet.	Alabama River at Selma, Ala.	Black Warrior River near Cordova, Ala.	Black Warrior River at Tuscaloosa, Ala.	Tombigbee River at Columbus, Miss.	Tombigbee River at Epes, Ala.	Youghiogheny River at Friendsville, Md.	Cheat River near Uneva, W. Va.	Greenbrier River at Alderson, W. Va.	New River at Radford, Va.	South Fork of Holston River at Bluff City, Tenn.	French Broad River near Asheville, N. C.	French Broad River at Oldtown, Tenn.
−3.5				566								
−3.4				582								
−3.2				615								
−3.0				650								
−2.8				687								
−2.6				729								
−2.4				780								
−2.2				842								
−2.0			88	915								
−1.8			92	1,000								
−1.6			100	1,097								
−1.4			110	1,206								
−1.2			120	1,328								
−1.0		75	130	1,464								
−0.8		155	150	1,613					600			
−0.6		260	175	1,775					675			
−0.4		384	205	1,957					850			
−0.2		518	240	2,165	810				1,075			
0.0	6,700	660	280	2,410	880				1,400			
0.2	6,845	810	340	2,686	985				1,800	310		
0.4	7,009	968	400	2,962	1,103				2,220	346		
0.6	7,189	1,134	460	3,238	1,226				2,700	444		
0.8	7,384	1,307	530	3,514	1,353				3,250	576		700
1.0	7,596	1,486	600	3,790	1,484				3,860	730		1,090
1.2	7,818	1,669	670	4,066	1,619			60	4,765	896		1,580
1.4	8,045	1,856	750	4,342	1,758		209	120	5,715	1,070		2,080
1.6	8,276	2,047	830	4,618	1,903		273	220	6,720	1,255		2,600
1.8	8,511	2,242	910	4,894	2,050		357	350	7,760	1,456		3,130
2.0	8,750	2,444	1,000	5,170	2,200		465	505	8,800	1,670	800	3,830
2.2	8,996	2,652	1,090	5,446	2,353		623	685	9,840	1,890	890	4,670
2.4	9,256	2,868	1,180	5,722	2,510		864	920	10,880	2,110	1,020	5,550
2.6	9,532	3,118	1,270	5,998	2,641		1,136	1,205	11,920	2,330	1,190	6,560
2.8	9,822	3,404	1,370	6,274	2,835		1,408	1,535	12,960	2,550	1,390	7,680
3.0	10,120	3,700	1,470	6,550	3,002		1,680	1,900	14,000	2,770	1,590	8,800
3.2	10,428	3,996	1,570	6,826	3,172		1,956	2,330	15,040	2,990	1,790	9,920
3.4	10,752	4,292	1,670	7,102	3,345		2,232	2,770	16,080	3,210	2,000	11,040
3.6	11,092	4,588	1,780	7,378	3,520	20	2,510	3,240	17,120	3,430	2,230	12,160
3.8	11,448	4,884	1,890	7,654	3,698	65	2,790	3,720	18,160	3,650	2,485	13,280
4.0	11,820	5,180	2,000	7,930	3,878	130	3,070	4,200	19,200	3,870	2,760	14,400
4.2	12,220	5,476	2,111	8,206	4,060	210	3,350	4,680	20,240	4,130	3,060	15,540
4.4	12,660	5,772	2,222	8,482	4,245	300	3,630	5,160	21,280	4,430	3,410	16,680
4.6	13,150	6,068	2,333	8,758	4,432	400	3,910	5,560	22,320	4,795	3,800	17,820
4.8	13,668	6,364	2,444	9,034	4,622	515	4,190	6,180	23,360	5,245	4,250	18,960
5.0	14,200	6,660	2,555	9,310	4,815	640	4,470	6,700	24,400	5,900	4,740	20,100
5.2	14,732	6,956	2,666	9,586	5,010	785	4,750	7,220	25,440	6,740	5,275	21,280
5.4	15,264	7,252	2,777	9,862	5,208	955	5,030	7,740	26,480	7,580	5,905	22,460
5.6	15,796	7,548	2,888	10,138	5,409	1,150	5,310	8,300	27,520	8,420	6,600	23,640
5.8	16,328	7,844	3,000	10,414	5,613	1,372	5,590	8,900	28,560	9,260	7,300	24,820
6.0	16,860	8,140	3,110	10,690	5,820	1,600	5,870	9,500	29,600	10,100	8,000	26,000
6.5	18,190	8,880	3,370	11,380	6,350	2,170	6,570	11,000	32,200	12,200	9,750	29,200
7.0	19,520	9,620	3,665	12,070	6,900	2,740	7,270	12,500	34,800	14,300	11,500	32,450
7.5	20,850	10,360	3,925	12,760	7,500	3,310		14,000	37,400	16,400	13,300	35,700
8.0	22,180	11,100	4,220	13,450	8,100	3,880		15,600	40,000	18,500	15,100	38,950
9.0	24,840	12,580	4,775	14,830	9,300	5,020		19,000	45,200	22,700	18,800	45,450
10.0	27,500	14,060	5,330	16,210	10,500			22,500	50,400	26,900	22,600	51,950
11.0	30,160	15,540	5,885	17,590	11,700			26,500	55,600	31,100	26,550	
12.0	32,820	17,020	6,440	18,970	12,900			31,200	60,800	35,300	30,670	
13.0	35,480	18,500	6,995	20,350	14,100			36,200	66,000	39,500		
14.0	38,140	19,980	7,550	21,730	15,300			41,200	71,200	43,700		
15.0	40,800	21,460	8,105	23,110	16,500			46,200	76,400			
20.0	54,100	28,860	10,380	30,010	22,500				102,400			
25.0	67,400	36,260	16,000	36,910	28,500				128,400			
30.0	80,700	43,660	24,600		34,500							
35.0	94,000		35,000		40,500							
40.0	107,300		49,000		46,500							
45.0	120,600		65,250									
50.0			84,000									
55.0			102,750									
60.0			121,500									

Rating tables for stations in Tennessee, North Carolina, and Georgia.

[Discharge in second-feet.]

Gage height, in feet.	Tennessee River at Knoxville, Tenn.	Tuckasegee River at Bryson, N. C.	Little Tennessee River at Judson, N. C.	Hiwassee River at Murphy, N. C.	Nottely River at Ranger, N. C.	Hiwassee River at Reliance, Tenn.	Hiwassee River at Charleston, Tenn.	Toccoa River near Blue Ridge, Ga.	Tennessee River at Chattanooga, Tenn.
0.00	3,450								
0.20	3,850						1,200		
0.40	4,250						1,380		
0.60	4,650						1,580		
0.80	5,050						1,820		
1.00	5,600	400					2,100		
1.20	6,170	600					2,390		
1.40	6,760	830				1,485	2,680		
1.60	7,370	1,080				1,805	2,970		
1.80	8,000	1,370				2,170	3,260		
2.00	8,650	1,700				2,600	3,550		11,250
2.20	9,320	2,065	325			3,090	3,840		12,080
2.40	10,010	2,450	425			3,620	4,130		12,930
2.60	10,720	2,850	585			4,190	4,420	460	13,860
2.80	11,450	3,260	785			4,800	4,710	552	14,680
3.00	12,200	3,675	1,000		260	5,450	5,000	666	15,600
3.20	12,970	4,110	1,250		320	6,140	5,290	804	16,550
3.40	13,760	4,565	1,500		380	6,870	5,580	969	17,550
3.60	14,570	5,035	1,800		440	7,640	5,870	1,162	18,550
3.80	15,398	5,515	2,100		500	8,450	6,160	1,376	19,600
4.00	16,242	6,000	2,400		560	9,300	6,450	1,590	20,800
4.20	17,102	6,510	2,770		620	10,190	6,740	1,804	22,040
4.40	17,978	7,060	3,140		680	11,120	7,030	2,018	23,280
4.60	18,870	7,640	3,510		740	12,080	7,320	2,232	24,520
4.80	19,778	8,220	3,880		800	13,040	7,610	2,446	25,760
5.00	20,700	8,800	4,250	340	860	14,000	7,900	2,660	27,000
5.20	21,630	9,475	4,685	450	920	14,960	8,190	2,874	28,240
5.40	22,560	10,250	5,155	590	980	15,920	8,480	3,088	29,480
5.60	23,490	11,125	5,625	750	1,040	16,880	8,770	3,302	30,720
5.80	24,420	12,100	6,100	940	1,100	17,840	9,060	3,516	31,960
6.00	25,350	13,200	6,580	1,200	1,160	18,800	9,350	3,730	33,200
6.20	26,280	14,360	7,070	1,560	1,220	19,760	9,640	3,944	34,500
6.40	27,210	15,520	7,560	1,920	1,280	20,790	9,930	4,158	35,800
6.60	28,140	16,680	8,050	2,280	1,340	21,680	10,220	4,372	37,100
6.80	29,070	17,840	8,540	2,640	1,400	22,640	10,510	4,586	38,400
7.00	30,000	19,000	9,030	3,000	1,460	23,600	10,800	4,800	39,400
7.20	30,930	20,160		3,360	1,520	24,560	11,090	5,014	41,000
7.40	31,860	21,320		3,720	1,580	25,520	11,380	5,228	42,300
7.60	32,790	22,480		4,080	1,640	26,480	11,670	5,442	43,600
7.80	33,720	23,640		4,440	1,700	27,440	11,960	5,656	44,900
8.00	34,650	24,800		4,800	1,760	28,400	12,250	5,870	46,200
8.50	36,975	27,700		5,700	1,910	30,800	12,975	6,405	49,450
9.00	39,300	30,600		6,600	2,060		13,700	6,940	52,700
9.50	41,625	33,500		7,500	2,210		14,425	7,475	55,950
10.00	43,950	36,400		8,400	2,360		15,150	8,010	59,200
10.50	46,275	39,300		9,300	2,510		15,875	8,545	62,450
11.00	48,600	42,200		10,200	2,660		16,600	9,080	65,700
11.50	50,925			11,100	2,910		17,325	9,615	68,950
12.00	53,250			12,000	2,960		18,050	10,150	72,200
12.50	55,575			12,900	3,110		18,775	10,685	75,450
13.00	57,900			13,800	3,260		19,500	11,220	78,700
13.50	60,225			14,700	3,410		20,225	11,755	81,950
14.00	62,550			15,600	3,560		20,950	12,290	85,200
14.50	64,875			16,500	3,710		21,675		88,450
15.00	67,200			17,400	3,860		22,400		91,700
15.50	69,525			18,300	4,010		23,125		94,950
16.00	71,850			19,200	4,160		23,850		98,200
16.50	74,175			20,100	4,310		24,575		101,450
17.00	76,500			21,000	4,460		25,300		104,700
18.00	81,150			22,800	4,760		26,750		111,200
19.00	85,800			24,600			28,200		117,700
20.00	90,450						29,650		124,200
21.00	95,100						31,100		130,700
22.00	99,750						32,550		137,200
23.00	104,400						34,000		143,700
24.00	109,050						35,450		150,200
25.00	113,700						36,900		156,700
30.00	136,950								189,200
35.00									221,700
40.00									254,200

[Continued in Water-Supply Paper No. 66, where will be found measurements of streams west of the Mississippi River.]

INDEX.

A.

Page.

Abrams, C. F., aid by 61
Adams, A. S., aid by 259
Alabama River at Montgomery, Ala., measurements of 281–282
at Selma, Ala., measurements of 282
rating table for 323
Albany, Ga., hydrographic work at 266–267
Alcovy River near Covington, Ga., measurements of 260–261
rating table for 321
Alderson, W. Va., hydrographic work at. 290–291
rating table for 323
Alexander City, Ala., hydrographic work near 271–272
rating table for 322
Allenwood, Pa., hydrographic work at... 225–226
Almon, Ga., hydrographic work at..... 261–262
rating table for 321
Alston, S. C., hydrographic work at..... 250
rating table for 320
Altamaha River Basin, miscellaneous measurements in 263
Amsterdam, N. Y., gage at, description of . 194
Mohawk River near, elevation of surface of 188, 193
fall of 200, 201
Anderson, L. W., work of 316
Androscoggin River at Rumford Falls, Me., measurements of 20–21
Antietam Creek near Sharpsburg, Md., measurements of 230–231
rating table for 318
Apalachee River near Buckhead, Ga., measurements of 258–259
rating table for 321
Appomattox River at Mattoax, Va., measurements of 238–239
rating table for 319
Asheville, N. C., hydrographic work near . 301
rating table for 323
Athens, Ga., hydrographic work near.... 256–257
rating table for 321
Augusta, Ga., hydrographic work at..... 254–255
rating table for 320
Augusta, Me., hydrographic work near.... 20

B.

Babb, C. C., stations established by 229, 301
Babb, C. C., and Humphreys, D. C., stations established by 235, 236
Babcock, S. E., aid by 152
Bailey, G. I., aid by 58
Baldwinsville, N. Y., hydrographic work at 128–129, 130–131

Page.

Barnett Shoals, Georgia, hydrographic work at 257–258
rating table for 321
Battaile, P. C., aid by 288
Beaver River, New York, features of..... 100
measurements of, at Tisse's Bridge ... 100, 101
Belgium, N. Y., hydrographic work at..... 129
Benedict, F. N., reference to report by..... 36
Bennett, T. H., aid by 137
Berkeley, R. I., hydrographic work at..... 27–29
Berner, Ga., hydrographic work at..... 263
Bethlehem, Pa., hydrographic work at... 213–214
Betts, H. R., aid by 193
Big Indian, N. Y., water power at..... 66
Big Sandy Creek near Dadeville, Ala., measurements of 273
rating table for 322
Birch, F., aid by 194
Birmingham, Conn., hydrographic work at. 90
Black Creek, New York, measurement of .. 154
Black River, New York, features of 102–103
measurements of, at Huntingtonville dam 104–105
Black River Canal, New York, Forestport feeder of, measurements of 143
Black Warrior River at Cordova, Ala., rating table for 323
at Tuscaloosa, Ala., measurements of. 284–285
rating table for 323
See also Mulberry Fork of Black Warrior River.
Blackstone Canal at Berkeley, R. I., measurements of 27, 28, 29
Blackstone River at Berkeley, R. I., measurements of 27, 28
Blackwater Creek, New Jersey, measurements of 213
Blueridge, Ga., hydrographic work near.. 310–311
rating table for 324
Bluff City, Tenn., hydrographic work at . 297–298
rating table for 323
Boiceville, N. Y., water power at 66
Bradley Brook reservoir, N. Y., capacity of. 148
Breed, O. C., aid by 133
Brewerton, N. Y., hydrographic work at. 131–132
Bridgeport, N. Y., hydrographic work at. 112–114
water powers at 116
Brinsdale, D. S., aid by 90
Broad River (of Carolinas) near Alston, S. C., measurements of 250
rating table for 320
near Dellinger, S. C., measurements of . 249
Broad River (of Georgia) near Carlton, Ga., measurements of 255–256
rating table for 321

Page.
Brown, C. N., work in charge of..... 295
Brown, J., aid by..... 194
Brown station, N. Y., water power at..... 66
Bryson, N. C., hydrographic work at..... 304–305
rating table for..... 324
Buchanan, Va., hydrographic work at... 236–237
rating table for..... 319
Buckhead, Ga., hydrographic work near. 258–259
rating table for..... 321
Bucklin, W. B., aid by..... 194
Bucksbridge, N. Y., water power at..... 33
Buford, Ga., hydrographic work near.... 268–269
rating table for..... 321
Burgess, F. H., aid by..... 193
Butler, Tenn., hydrographic work at 298, 299
Butler, W., aid by..... 193

C.

Cahaba River at Centerville, Ala., measurements of..... 283
Calhoun Falls, S. C., hydrographic work near..... 253–254
rating table for..... 320
Camden, N. Y., water powers at..... 109
Camp Creek near McDonough, Ga., measurements of..... 263
Canajoharie, N. Y., gage at, description of. 194
Mohawk River near, elevation of surface of..... 190, 193
fall of..... 202
Canton, Ga., hydrographic work near.... 275–276
rating table for..... 322
Canton, N. Y., water power at..... 33
Cape Fear River at Fayetteville, N. C., measurements of..... 244–245
rating table for..... 320
Capron, N. Y., water power at..... 150
Carey, C. E., aid by..... 75
Carlton, Ga., hydrographic work near.... 255–256
rating table for..... 321
Carrabasset River at North Anson, Me., measurements of..... 19
Carters, Ga., hydrographic work at..... 276–277
rating table for..... 322
Cartersville, Va., hydrographic work at.... 238
rating table for..... 319
Catawba, N. C., hydrographic work at..... 247
rating table for..... 320
Catawba River near Catawba, N. C., measurements of..... 247–248
rating table for..... 320
near Morganton, N. C., measurements of..... 247
near Rockhill, S. C., measurements of. 248–249
rating table for..... 320
Catskill Creek, New York, drainage areas of..... 60
features of..... 61
measurements of, at South Cairo..... 62–63
water powers developed on, table showing..... 62
Caughdenoy, N. Y., weirs at..... 132
Cayadutta Creek near Johnstown, N. Y., measurements of..... 166–167
Cazenovia, N. Y., water power at..... 116
Centerville, Ala., hydrographic work at... 283

Page.
Chadwicks, N. Y., water powers at..... 150
Chambly, Province of Quebec, hydrographic work at..... 39–40, 42
Charleston, Tenn., hydrographic work at. 309–310
rating table for..... 324
Chase Mills, N. Y., water power at..... 33
Chattahoochee River near Buford, Ga., measurements of..... 268–269
rating table for..... 321
near Gainesville, Ga., measurements of..... 267–268
near Oakdale, Ga., measurements of.. 269–270
rating table for..... 322
near West Point, Ga., measurements of..... 270–271
rating table for..... 322
Chattanooga, Tenn., hydrographic work at..... 311–312
rating table for..... 324
Cheat River near Uneva, W. Va., measurements of..... 290
rating table for..... 323
Chenango River, New York, storage reservoir on..... 148
Chittenango, N. Y., hydrographic work at..... 114–116
water powers at..... 116
Chittenango Creek, New York, measurements of, at Bridgeport..... 112–114
at Chittenango..... 114–116
Chittenango Falls, N. Y., waters powers at. 116
Chittenango Springs, N. Y., water powers at and near..... 116
Chucky Valley, Tenn., hydrographic work near..... 300
Clayville, N. Y., water powers at..... 150
Clinton, Mass., hydrographic work at..... 22–25
stream measurements at, methods of .. 23–24
Clute, L. S., aid by..... 193
Cobbosseecontee River near Augusta, Me., measurements of..... 19–20
Codman, J. E., information furnished by .. 215, 216, 217, 219
Cohoes Company's dam, New York, gage at, description of..... 193
Mohawk River near, elevation of surface at..... 184, 193
fall of..... 198
Columbus, Miss., hydrographic work at ... 285
rating table for..... 323
Columbus, Ohio, hydrographic work at.. 295–296
Conn, J. C., measurements by..... 269
Connecticut River near Hartford, Conn., measurements of..... 30–31
near Holyoke, Mass., measurements of, reference to..... 30
near Orford, N. H., measurements of... 29–30
rating table for..... 318
Cooper Falls, N. Y., water power at..... 35
Coosa River near Locks Nos. 4 and 5, Alabama, measurements of..... 280
near Riverside, Ala., measurements of..... 279–280
rating table for..... 322
near Rome, Ga., measurements of.... 278–279
rating table for..... 322

Page.
Coosawattee River at Carters, Ga., measurements of 276–277
rating table for 322
Cordova, Ala., hydrographic work near .. 283–284
rating table for 323
Covington, Ga., hydrographic work near. 260–261
rating table for 321
Cranberry Lake, New York, features of 34
Croghan, N. Y., hydrographic work at 101
Croton River, New York, features of 76
measurements of, at old Croton dam ... 80–84
Croton River Basin, evaporation in, water surface exposed to 79
precipitation in 84–85
relation of annual precipitation to run-off 80
storage reservoirs in, table showing 78
yield of 77
Cumberland River at Nashville, Tenn., measurements of 296
Cumnock, N. C., hydrographic work at .. 243–244
rating table for 320
Curtis, N. C., measurements by 240, 245, 247, 291, 292, 293

D.

Dadeville, Ala., hydrographic work near .. 273
rating table for 322
Dan River at South Boston, Va., measurements of 240–241
rating table for 319
Danville, Pa., hydrographic work at 220–221
Dashville, N. Y., water power at 74
Davis, A. P., stations established by .. 230, 231, 232
Dead River at The Forks, Me., measurements of 18
Deep River at Cumnock, N. C., measurements of 243–244
rating table for 320
Delaware and Hudson Canal, feeding of, from Rondout Creek, New York. 68–69
Delaware River at Lambertville, N. J., measurements of 214
rating table for 318
Dellinger, S. C., hydrographic work at 249
Diggins, L., aid by 172
Discharge tables, daily, description of 97–98
Dodgeville, N. Y., water power at 36
Dolgeville, N. Y., hydrographic work at .. 158–161
Douglas, J., aid by 63
Dover Plains, N. Y., hydrographic work at. 86
Drowne, H. B., aid by 27, 28
Dublin, Ga., hydrographic work near 259–260
rating table for 321
Duncan, J. A., work of 315, 316
Dunsbach Ferry, New York, hydrographic work at 180–183
Durgin, Jeremiah, jr., aid by 18

E.

East Branch of Fish Creek, New York, measurement of 109
East Canada Creek, New York measurements of, at Dolgeville 158–161
water powers on 160
East Durham, N. Y., water power at 62

Page.
East Nassau, N. Y., hydrographic work at. 54, 55, 56
Eaton Brook reservoir, New York, capacity of 148
Eddyville, N. Y., water power at 70
Elk Creek at Lineback, Tenn., measurements of 299–300
Emeryville, N. Y., water power at 35
Epes, Ala., hydrographic work near 286
rating table for 323
Erie Canal, dates of opening and closing .. 180
Esopus Creek, New York, drainage areas of. 60, 65
features of 63
flow of 65
measurements of, at Kingston 64
water powers on, table showing 66
Etowah River at Canton, Ga., measurements of 275–276
rating table for 322
Evans, M. E., cited 65

F.

Fayette, W. Va., hydrographic work at 294
Fayetteville, N. C., hydrographic work at. 244–245
rating table for 320
Fine, N. Y., water power at 36
Fish Creek, New York, measurements of ... 108
See also West Branch; East Branch.
Fisher, E. A., aid by 140
Fishkill, N. Y., water power at 76
Fishkill Creek, New York, drainage areas of. 60
features of 74
measurements of, at Glenham 75–76
water powers on, table showing 76
Flint River at Albany, Ga., measurements of 266–267
at Woodbury, Ga., measurements of. 265–266
rating table for 321
Flovilla, Ga., hydrographic work at 262–263
rating table for 321
Flynn, B. H., measurements by 313, 314
station established by 313
Flynn, B. H., and Pressey, H. A., station established by 314
Foote, C. H., aid by 307
Forestport feeder of Black River Canal, New York, measurements of ... 143
Formulas employed in calculation of gaging records 95–97
Fort Edward, N. Y., hydrographic work at . 48–50
Fort Hunter, N. Y., gage at, description of .. 194
hydrographic work at 167–169
Mohawk River at, elevation of surface of 189, 193
fall of 201
Frederick, Md., hydrographic work near. 234–235
rating table for 319
Frederick, Pa., hydrographic work at 217
Freehold, N. Y., water power at 62
Freeman, J. R., cited 59, 77, 87, 88
Fremont, Ohio, hydrographic work at 314
French Broad River near Asheville, N. C., measurements of 301
rating table for 323
near Oldtown, Tenn., measurements of. 302
rating table for 323

Page.
Frenchs Mill, N. Y., hydrographic work at. 58–59
Friendsville, Md., hydrographic work at .. 289
rating table for 323
Front Royal, Va., hydrographic work at... 232
rating table for 319
Fullerville, N. Y., water power at 36
Fulton, N. Y., hydrographic work at..... 133–134

G.

Gaging, methods of..... 91–98
Gainesville, Ga., hydrographic work near. 267–268
Galeville, N. Y., water power at 74
Gaylordsville, Conn., hydrographic work at..... 87, 88–90
rating table for..... 318
Gears Corners, N. Y., water power at 36
Genesee River, New York, drainage areas of, table showing..... 141
features of..... 139–140
measurements of, at Rochester 140–141
Gilbert, G. H., aid by 27, 28
Glasgow, Va., hydrographic work at..... 235–236
rating table for..... 319
Glen Erie, N. Y., water power at..... 66
Glenham, N. Y., water power at 76
Glover, A. E., aid by 27
Goodfellow, F., aid by 46
Gouverneur, N. Y., water power at 35
Gowen, C. S., cited 77
Grahamville, N. Y., water power at..... 70
Grand Rapids, Mich,, hydrographic work at 315–317
Grand River, measurements of, at Grand Rapids, Mich..... 315–317
at North Lansing, Mich..... 315
Grasse River, New York, water powers on. 33
Graves, E. D., aid by..... 30
measurements by 240
Graves, E., and Myers, E. W., measurements by 238
Greenbrier River at Alderson, W. Va., measurements of..... 290–291
rating table for..... 323
Greenville, N. Y., water power at..... 62
Grover, N. C., gaging stations established by 16, 19
stream measurements by..... 16, 17

H.

Hailsboro, N. Y., water power at..... 35
Hale, R. A., acknowledgments to..... 22
Hall, B. M., measurements by..... 257
station established by..... 310
Hall, J. R., measurements by 271, 272, 273, 274, 281, 283
stations established by 272, 273
Hall, Max, measurements by..... 254, 259, 260, 261, 265, 266, 268, 274, 275, 282, 297, 303, 308, 309
Hall, O, P., measurements by 276, 303, 307, 308, 310
stations established by 307, 308
Hall, S. D., work of 283
Hannon, C., aid by..... 99
Hanson, A. H., aid by..... 15
Hardy, G. F., stream measurements by 14

Page.
Harmony Grove, Ga., hydrographic work near 263
Harrisburg, Pa., hydrographic work at... 227–228
rating table for..... 318
Harrisville, N. Y., water power at..... 36
Hartford, Conn., hydrographic work near . 30–31
Hatch Lake reservoir, New York, capacity of..... 148
Henderson, J. S., measurements by..... 240
Herkimer, N. Y., Mohawk River near, elevation of surface of 192, 193
fall of 204
Heuvelton, N. Y., hydrographic work at .. 34
water power at 35
Hill, J. E., gaging station established by... 27
Hillabee Creek near Alexander City, Ala., measurements of 271–272
rating table for..... 322
Hilton, N. Q., aid by 19
Himes, A. J., aid by 132
Hinds, F. E., aid by 102
Hiwassee River at Charleston, Tenn., measurements of 309–310
rating table for..... 324
at Murphy, N. C., measurements of .. 306–307
rating table for..... 324
at Reliance, Tenn., measurements of. 308–309
rating table for..... 324
Hoffman, W., work of..... 194
Hoffmans Ferry, N. Y., gage at, description of..... 194
Mohawk River near, elevation of surface of..... 188, 193
fall of..... 200
Holcomb Rock, Va., hydrographic work at. 237
Holden, C. A., acknowledgments to..... 29
Hollister, G. B., measurements by.. 72, 75, 210, 211
Hollingsworth & Whitney Pulp and Paper Company, aid by 16
Holston River. *See* South Fork of Holston River.
Holyoke, Mass., hydrographic work at..... 30
Honk Falls, New York, hydrographic work at..... 70
Horton, R. E., gaging stations established by. 60
measurements by..... 72, 75, 147, 162, 167, 168, 173, 176
reconnaissance by..... 59
work of..... 121, 136
Housatonic River at Gaylordsville, Conn., measurements of 87, 88–90
rating table for..... 318
drainage areas of..... 60
gagings of, miscellaneous 90
water powers on, undeveloped..... 88
Hout, W., aid by 194
Howell, D, J., aid by 180, 184
Huben, A. E., aid by 67
Hudson River, measurements of, at Fort Edward..... 48, 49–50
at Mechanicville 44, 50–53
Hudson River drainage basin, upper, hydrographic work in..... 42–53
Hull, H. H., aid by..... 90
Humphreys, D. C., measurements by..... 235, 238, 241, 290, 293, 294
stations established by..... 241, 293

Page.
Humphreys, D. C., and Babb, C. C., stations established by 235, 236, 290
Huntingtonville, N. Y., hydrographic work at 102–105
Hurst, J., aid by 286
Hutton, W. R., measurements by 65

I.

Indian Creek, Pennsylvania, measurements of 289–290
Indian Lake dam, Hamilton County, N. Y., meteorological station at 43
Indian Lake reservoir, New York, features of 42–45
Indian River above Philadelphia, N. Y., measurements of 34
at Indian Lake dam, Hamilton County, N. Y., features of 42–43

J.

Jacks Reef bridge, New York, hydrographic work at 129
Jackson, Miss., hydrographic work at 286
James River at Buchanan, Va., measurements of 236–237
rating table for 319
at Cartersville, Va., measurements of 238
rating table for 319
at Holcomb Rock, Va., measurements of 237
John River near Morganton, N. C., measurements of 248
Johnson, W. C., measurements by 37
Johnstown, N. Y., hydrographic work at .. 166–167
Jordan, N. Y., hydrographic work at .. 121–122, 126
Judson, N. C., hydrographic work at 305–306
rating table for 324
Juliette, Ga., hydrographic work near 263–264
rating table for 321
Juniata River at Newport, Pa., measurements of 226
rating table for 318

K.

Kennebec River, measurements of, at North Anson, Me 17
at The Forks, Me 16
Kent, Conn., hydrographic work at 90
Kenwood, N. Y., hydrographic work at .. 110–111
Kibbie, A., aid by 140
Kinderhook Creek at East Nassau and Wilson's dam, New York, measurements of 53–57
Kingsley Brook reservoir, New York, capacity of 148
Kingston, N. Y., hydrographic work at 64
Knight, C. H., information furnished by ... 289
Knoxville, Tenn., hydrographic work at. 303–304
rating table for 324

L.

Lackawack, N. Y., water power at 70
Lake Champlain, elevation of, relation to, discharge of Richelieu River ... 38
features of 38

Page.
Lake Champlain drainage basin, run-off of 39–40, 42
Lake Cochituate watershed, Massachusetts, run-off and rainfall for 26
Lake Ontario drainage basin, hydrographic work in 98–142
Lakes Mills, N. Y., water power at 62
Lambertville, N. J., hydrographic work at. 214
rating table for 318
Landreth, O. H., reference to 166
Landreth, W. B., aid by 184
Lawrence, Mass., hydrographic work at, reference to 22
Lawrenceville, N. Y., water power at 70
Leeds, N. Y., water power at 62
Lehigh River near Bethlehem, Pa., measurements of 213–214
Leland Pond reservoir, New York, capacity of 148
Lempe, F. J., aid by 171
Lewisville, N. Y., water power at 33
Lineback, Tenn., hydrographic work at. 299–300
Little River, New York, water power on, table showing 33
Little Falls, N. Y., hydrographic work at. 162–165
Mohawk River near, elevation of surface of 192, 193
fall of 203, 204
Little Tennessee River at Judson, N. C., measurements of 305–306
rating table for 324
Lockwood, W. D., measurements by 106, 147, 168, 176
Long Branch Creek near McDonough, Ga., measurements of 263
Luther, J. D., acknowledgments to 95
measurements by 173
Loomis, H., aid by 90
Lyons Falls, New York, water power near .. 100
Lyonsdale, N. Y., water powers at and near. 100

M.

Macon, Ga., hydrographic work at 264–265
rating table for 321
Madison, S. C., hydrographic work near. 252–253
rating table for 320
Madison Brook reservoir, New York, capacity of 148
Madrid, N. Y., water power at 33
Manantico Creek, New Jersey, measurements of 213
Manaway Branch, New Jersey, measurements of 213
Massena, N. Y., water power at 33
Mather, E., station established by 227
Matteawan, N. Y., water power at 76
Mattoax, Va., hydrographic work at 238–239
rating table for 319
Maumee River near Waterville, Ohio, measurements of 313–314
McCalla, R. C., aid by 284
McClatchy, R. M., aid by 281
McConnellsville, N. Y., hydrographic work at 108–110
water power at 109

Page.
McDonough, Ga., hydrographic work near. 263
McIver, J. A., aid by 243
McKeever, N. Y., hydrographic work near. 98–96
Mechanicville, N. Y., hydrographic work at 44, 50–53
Meeker, G. H., aid by 132
Megatchie, N. Y., water power at 35
Melton, C. E., aid by 270
Merrimac River at Lawrence, Mass., measurements of, reference to 22
Merriman, M., aid by 213
Metropolitan Water and Sewage Board, Clinton, Mass., extract from annual report of 23–24
Middle Oconee River at Athens, Ga., measurements of 256–257
rating table for 321
Middleville, N. Y., hydrographic work at. 155–157
Mill Point, N. Y., hydrographic work at . 169–170
Mills, H. F., aid by 21
Millville, W. Va., hydrographic work at.... 233
rating table for 319
Milstead, Ala., hydrographic work near . 274–275
rating table for 322
Minetto, N. Y., hydrographic work at.... 134–135
Mingus, W., aid by 306
Mississippi River at St. Paul, Minn., measurements of 312–313
Mitchell, G. A., measurements by 212, 213
Mixer, C. A., aid by 20
Moffitt, J. H., aid by 122
Mohawk River, elevation of surface of .. 184–193
fall of 198–204
high-water discharge of 207–209
measurements of, at Dunsbach Ferry. 180–183
at Little Falls 162–165
at Rexford Flats 176–180
at Ridge Mills 144–145
at Rocky Rift dam 165–166
at Schenectady 172–175
at Utica 151–153
slope gagings of 184–209
Mohawk River Basin, measurements in.. 142–209
Mohawk Valley, dams and canal feeders in 143
Montague, Me., hydrographic work at..... 15
Montgomery, Ala., hydrographic work at. 281–282
Montgomery, N. Y., water power at..... 74
Monocacy River near Frederick, Md., measurements of 234–235
rating table for 319
Monroe, G. H., aid by 87
Moose River, N. Y., hydrographic work near 99
Moose River, New York, measurements of, near McKeever 98–99
near Moose River 99
water powers on 100
Morganton, N. C., hydrographic work at.. 247, 248
Morley, N. Y., water power at 33
Mount Morris, N. Y., hydrographic work at. 141
Mulberry Fork of Black Warrior River near Cordova, Ala., measurements of 283–284
Murphy, E. C., measurements by 147
work of 121, 136

Page.
Murphy, N. C., hydrographic work at.... 306–307
rating table for 324
Murray, F. A., measurements by 251, 252, 254, 259, 260, 261, 262, 264, 265, 266, 268, 269, 278
Myers, E. W., measurements by 239, 240, 242, 243, 244, 246, 247, 248, 250, 297, 298, 299, 300, 301, 302, 304, 305, 306
stations established by 239, 240
Myers, E. W., and Graves, E., measurements by 238
Mystic Lake, Massachusetts, description of, reference to 27

N.

Napanock, N. Y., water power at..... 70
Nashua River, Massachusetts. *See* South Branch of Nashua River.
Nashville, Tenn., hydrographic work at... 296
Neal, N. C., hydrographic work at 242–243
rating table for 320
Neshaminy Creek, Pennsylvania, measurements of 216
New Milford Falls, Connecticut, hydrographic work at 90
Newport, Pa., hydrographic work at..... 226
rating table for 318
Newport, Tenn., hydrographic work at .. 302–303
Newton Falls, N. Y., water power at..... 36
New River, N. C., hydrographic work at... 292
New River near Fayette, W. Va., measurements of 294
near Oldtown, Va., measurements of... 293
near Radford, Va., measurements of.. 293–294
rating table for 323
See also North Fork of New River; South Fork of New River.
Newell, F. H., letter of transmittal by..... 11
New Hartford, N. Y., water powers at..... 150
New Paltz, N. Y., hydrographic work at... 72–74
New Paltz River. *See* Wallkill River.
New York streams, drainage areas of 60
gaging of, methods employed in 91–95
gaging stations on, table showing..... 95
New York City, water supply for, sources of. 59–60
New York Mills, N. Y., hydrographic work at 149
water powers at 150
New York State, cooperation by..... 59, 91
Nichols, L. L., cited 105
Nickerson, J. H., work of 194
Nolichucky River near Chucky Valley, Tennessee, measurements of 300
Normanskill Creek, New York, features of. 58
measurements of, at Frenchs Mill..... 58–59
North (of James) River at Glasgow, Va., measurements of 235–236
rating table for 319
North Anson, Me., hydrographic work at.. 16, 19
North Branch of Potomac River at Piedmont, W. Va., measurements of. 229
rating table for 318
North Branch of Shenandoah River near Riverton, Va., measurements of 231–232
rating table for 319

Page.

North Branch of Susquehanna River at Danville, Pa., measurements of ... 220–221
rating table for ... 318
at Wilkesbarre, Pa., measurements of .. 220
North Fork of New River at Weaversford, N. C., measurements of ... 291
North Lansing, Mich., hydrographic work at ... 315
Nottely River at Ranger, N. C., measurements of ... 307–308
rating table for ... 324
Nottingham, Ala., hydrographic work at .. 281
rating table for ... 322

O.

Oak Orchard, N. Y., State dam at ... 132
Oakdale, Ga., hydrographic work at ... 269–270
rating table for ... 322
O'Brien, J. J., aid by ... 85
Ocmulgee River near Berner, Ga., measurements of ... 263
near Flovilla, Ga., measurements of. 262–263
rating table for ... 321
near Macon, Ga., measurements of ... 264–265
rating table for ... 321
Oconee River at Barnett Shoals, Georgia, measurements of ... 257–258
rating table for ... 321
near Dublin, Ga., measurements of .. 259–260
rating table for ... 321
near Harmony Grove, Ga., measurements of ... 263
near Willis Ferry, Ga., measurement of. 263
See also Middle Oconee River.
Ogdensburg, N. Y., water power at ... 35
Oldtown, Tenn., hydrographic work at ... 302
rating table for ... 323
Oldtown, Va., hydrographic work at ... 293
Olentangy River at Columbus, Ohio, measurements of ... 295
Olivebridge, N. Y., water power at ... 66
Oneida Creek at Kenwood, N. Y., measurements of ... 110–111
Oneida River at Brewerton, N. Y., measurements of ... 131–132
Oostanaula River at Resaca, Ga., measurements of ... 277–278
rating table for ... 322
Orford, N. H., hydrographic work at ... 29–30
rating table for ... 318
Oriskany, N. Y., hydrographic work at .. 145–147
Oriskany Creek, New York, measurements of, at Oriskany ... 145–147
at Wood road bridge ... 147–149
Oswegatchie, N. Y., water power at ... 36
Oswegatchie River, N. Y., drainage areas of, table showing ... 33
hydrography of ... 33–35
measurements of, at Heuvelton ... 34
water powers on, tables showing ... 35–36
Oswego River, New York, drainage areas of, table showing ... 136
measurements of, above Minetto ... 134–135
at cable station ... 136
at Fulton ... 133–134
at high dam ... 137–139

Page.

Oswego River drainage basin, New York, pondageareas in, table showing. 135

P.

Parvins Branch, New Jersey, measurements of ... 213
Passaic River at Two Bridges, N. J., measurements of ... 210–211
rating table for ... 318
course and character of ... 210
Patapsco River at Woodstock, Md., measurements of ... 228
rating table for ... 318
Paul, E. G., measurements by ... 65, 73, 86, 214, 221, 225, 226, 227, 228, 229, 230, 231, 232, 233, 234, 290
stations established by ... 29, 87, 220, 225, 226, 228, 229, 230, 290
Pearl River at Jackson, Miss., measurements of ... 286–287
Pennsylvania Canal at Harrisburg, Pa., measurements of ... 227
Penobscot River, measurements of, at Montague, Me ... 15
at Sunk Haze Rips, Costigan, Me ... 14–15
Perkiomen Creek at Frederick, Pa., measurements of ... 217
Philadelphia, Pa., hydrographic work at and near ... 218, 219
Phillips, L. D., aid by ... 194
Phoenicia, N. Y., water power at ... 66
Piedmont, W. Va., hydrographic work at .. 229
rating table for ... 318
Pigeon River at Newport, Tenn., measurements of ... 302–303
Pine Hipp, N. Y., water power at ... 66
Place, A. E., measurements by ... 59, 60, 72, 75, 86
Point of Rocks, Md., hydrographic work at ... 233–234
rating table for ... 319
Point Pleasant, Pa., hydrographic work at. 215
Point Rock Village, N. Y., hydrographic work near ... 109
Pompton River at Two Bridges, N. J., measurements of ... 211–212
rating table for ... 318
Port Hickory, N. Y., water power at ... 70
Potomac River at Point of Rocks, Md., measurements of ... 233–234
rating table for ... 319
See also North Branch of Potomac River; South Branch of Potomac River.
Potsdam, N. Y., hydrographic work at ... 37
Pressey, H. A., reconnaissance by ... 59
Pressey, H. A., and Flynn, B. H., station established by ... 314
Presumpscot River at outlet of Sebago Lake, Maine, measurements of ... 21–22
Pulaski, N. Y., hydrographic work at ... 105–107
Pyrites, N. Y., water power at ... 33

R.

Radford, Va., hydrographic work at ... 293–294
rating table for ... 323
Rafter, G. W., aid by ... 140
Ragland, T. R., aid by ... 237

Page.
Randolph, Va., hydrographic work at.... 239–240
rating table for..... 319
Ranger, N. C., hydrographic work at..... 307–308
rating table for..... 324
Raquette River, New York, drainage areas of, table showing..... 37
hydrography of..... 36–38
water powers on..... 37–38
Raquette River Basin above Piercefield, N. Y., areas of lakes in..... 36
Ray, J. A., aid by..... 27
Red Mills, N. Y., water power at..... 74
Reilly, M. T., acknowledgments to..... 95
Reliance, Tenn., hydrographic work at.. 308–309
rating table for..... 324
Rensselaer Falls, New York, water power at 35
Resaca, Ga., hydrographic work at..... 277–278
rating table for..... 322
Rexford Flats, N. Y., gage at, description of. 193
hydrographic work at..... 176–180
Mohawk River near, elevation of surface of..... 186, 187, 193
fall of..... 199
Richelieu River at Chambly, Province of Quebec, measurements of..... 40–41
Ridge Mills, N. Y., hydrographic work at. 144–145
Rifton, N. Y., water power at..... 74
Riverside, Ala., hydrographic work near. 279–280
rating table for..... 322
Riverton, Va., hydrographic work near.. 231–232
rating table for..... 319
Roach River, Me., hydrographic work at.. 17–18
Roach River at Roach River, Me., measurements of..... 17–18
Roan Creek at Butler, Tenn., measurements of..... 299
Roanoke, Va., hydrographic work at.... 241–242
rating table for..... 319
Roanoke River at Neal, N. C., measurements of..... 242–243
rating table for..... 320
at Roanoke, Va., measurements of... 241–242
rating table for..... 319
Rochester, N. Y., hydrographic work at . 139–141
Rockhill, S. C., hydrographic work at ... 248–249
rating table for..... 320
Rocky Rift dam, New York, gage at, description of..... 194
hydrographic work at..... 165–166
Mohawk River near, elevation of surface of..... 191, 193
fall of..... 203
Rome, Ga., hydrographic work at..... 278–279
rating table for..... 322
Rondout Creek, New York, diversion from. 68–69
drainage areas of..... 60, 67
features of..... 66–67, 69–70
water powers on, table showing..... 70
measurements of, at Honk Falls..... 70
at Rosendale..... 68
Rosendale, N. Y., hydrographic work at... 68
Rumford Falls, Me., hydrographic work at. 21
Russell, N. Y., water power at..... 33

S.

St. Johnsville, N. Y., gage at, description of. 194
Mohawk River near, elevations of surface of..... 190, 193
fall of..... 202, 203

Page.
St. Lawrence River, streams tributary to, drainage areas of, table showing..... 32
St. Lawrence River drainage basin, hydrographic work in..... 31–42
St. Paul, Minn., hydrographic work at .. 312–313
Salisbury, N. C., hydrographic work at.... 246
rating table for..... 320
Salmon River, New York, measurements of, at Pulaski..... 105–107
water powers on, table showing..... 106
Saluda River at Waterloo, S. C., measurements of..... 250–251
rating table for..... 320
Sandusky River at Fremont, Ohio, measurements of..... 314
Saugerties, N. Y., water power at..... 66
Sauquoit, N. Y., water powers at..... 150
Sauquoit Creek, New York, measurements of, at New York Mills..... 149
at Yorkville..... 151
water powers on..... 150
Savannah River at Augusta, Ga., measurements of..... 254–255
rating table for..... 320
near Calhoun Falls, South Carolina, measurements of..... 253–254
rating table for..... 320
Sawkill Creek, New York, measurements of..... 65–66
Sawyer, C. H., aid by..... 17
Schenectady, N. Y., hydrographic work at..... 172–175
Mohawk River near, elevation of surface of..... 187, 193
fall of..... 199–200
Schlecht, W. W., aid by..... 59, 60
measurements by..... 72, 75, 86
Schoharie Creek, New York, measurements of, at Fort Hunter dam and aqueduct..... 167–169
at Mill Point..... 169–170
at Schoharie Falls..... 170–172
Schoharie Falls, New York, hydrographic work at..... 170–172
Schroon River at Warrensburg, N. Y., features of..... 45
measurements of..... 46–47
Schuyler, H. F., work of..... 158
Schuylkill River near Philadelphia, Pa., measurements of..... 219
Scioto River at Columbus, Ohio, measurements of..... 295–296
Sebago Lake, Maine, hydrographic work at outlet of..... 22
Seneca River, New York, features of..... 128–129
measurements of, at Baldwinsville... 130–131
Selma, Ala., hydrographic work at..... 282
rating table for..... 323
Sharpsburg, Md., hydrographic work near..... 230–231
rating table for..... 318
Shenandoah River at Millville, W. Va., measurements of..... 233
rating table for..... 319
See also North Branch of Shenandoah River; South Branch of Shenandoah River.

Page.
Shuford, R. E., measurements by 297, 300, 301, 302, 304, 305, 306
Sickman, A. F., acknowledgments to 30
Siloam, N. C., hydrographic work at 245
Simkins, E., aid by 194
Skaneateles, N. Y., hydrographic work at 117–118, 128
Skaneateles Lake, New York, drainage area of 117
measurements of, at State dam, Skaneateles 128
Skaneateles Lake dam, New York, measurements at 117–118
Skaneateles outlet, New York, measurements of, at Jordan 121–122, 126
at Stotts weir, Willowglen 118–121, 122
at Willowglen weir 123–126, 127–128
Smyth, C. H., jr., reference to paper by 35
Snyder, G. D., aid by 221
South Boston, Va., hydrographic work at. 240–241
rating table for 319
South Branch of Nashua River at Clinton, Mass., measurements of 22–25
South Branch of Potomac River near Springfield, W. Va., measurements of 229–230
rating table for 318
South Branch of Shenandoah River at Front Royal, Va., measurements of 232
rating table for 319
South Cairo, N. Y., hydrographic work at . 62
South Fork of Holston River at Bluff City, Tenn., measurements of 297–298
rating table for 323
South Fork of New River at New River, N. C., measurements of 292
Springfield, W. Va., hydrographic work at. 229–230
rating table for 318
Staunton River at Randolph, Va., measurements of 239–240
rating table for 319
Stearns, F. P., acknowledgments to 22
Stetson, H. C., aid by 17
Strahan, C. M., measurements by 257
stations established by 256, 257
Sturdevant, Ala., hydrographic work near. 272
Sudbury River watershed, Massachusetts, run-off and rainfall for 26
Sunk Haze Rips, near Costigan, Me., hydrographic work at 14–15
Susanna, Ala., hydrographic work at 273–274
rating table for 322
Susquehanna River at Harrisburg, Pa., measurements of 227–228
rating table for 318
See also North Branch of Susquehanna River; West Branch of Susquehanna River.
Sutter, F. A., aid by 114

T.

Taberg, N. Y., water power at 109
Talcville, N. Y., water power at 36
Talladega Creek at Nottingham, Ala., measurements of 281
rating table for 322
Page
Tallapoosa River near Milstead, Ala., measurements of 274–275
rating table for 322
near Sturdevant, Ala., measurements of 272
near Susanna, Ala., measurements of. 273–274
rating table for 322
Tallulah Falls, Ga., hydrographic work at 251–252
rating table for 320
Tallulah River at Tallulah Falls, Ga., measurements of 251–252
rating table for 320
Tenmile River, New York, drainage areas of 60
features of 85–86
measurements of, at Tabor's bridge 85, 86
Tenmile River and tributaries, New York, water privileges on 87
Tennessee River at Chattanooga, Tenn., measurements of 311–312
rating table for 324
at Knoxville, Tenn., measurements of. 303–304
rating table for 324
The Forks, Me., hydrographic work at 16, 18
Thomas, K. T., measurements by 251, 253, 255, 259, 262, 264, 265, 269, 270, 283, 284, 285, 286, 288, 303, 309, 311
Thompson, D. H., aid by 267
Toccoa River near Blueridge, Ga., measurements of 310–311
rating table for 324
Tohickon Creek at Point Pleasant, Pa., measurements of 215
Tombigee River at Columbus, Miss., measurements of 285
rating table for 323
near Epes, Ala., measurements of 286
rating table for 323
Towaliga River near Juliette, Ga., measurements of 263–264
rating table for 321
Tremper, E., aid by 72
Tuckahoe River, New Jersey, measurements of 212–213
Tuckasegee River at Bryson, N. C., measurements of 304–305
rating table for 324
Tugaloo River near Madison, S. C., measurements of 252–253
rating table for 320
Tuscaloosa, Ala., hydrographic work at.. 284–285
rating table for 323
Twin Rock bridge, New York, hydrographic work at 153–155
Two Bridges, New Jersey, hydrographic work at 210–212
rating table for 318
Twombly, A. H., stream measurements by. 19

U.

Uneva, W. Va., hydrographic work at 290
rating table for 323
United States Board of Engineers on Deep Waterways, acknowledgments to 38
data obtained for 108
Utica, N. Y., hydrograpnic work at..... 151–153

V.

Page.

Vedder, H. K., station established by..... 315
Vickers Ferry, New York, gage at, description of..... 193
Mohawk River near, elevation of surface of..... 186, 193
fall of 198, 199

W.

Waldon, N. Y., water power at..... 74
Walker, E. D., gaging station established by 172
measurements by 167, 168, 169, 173
work of..... 168
Walker, H. A., aid by 105
Wallkill, N. Y., water power at..... 74
Wallkill River, New York, drainage areas of..... 60, 73
features of..... 71
measurements of, at New Paltz 72–74
water powers on, table showing..... 74
Warren & Co., S. D., acknowledgments to . 21
Warrensburg, N. Y., hydrographic work at. 46–47
Washington Mills, N. Y., water powers at.. 150
Watauga River at Butler, Tenn., measurements of..... 298
Waterloo, S. C., hydrographic work at.... 250–251
rating table for 320
Waterville, Ohio, hydrographic work at.. 313–314
Weaversford, N. C., hydrographic work at. 291
West Branch of Fish Creek, New York, features of 108
measurements of, at McConnellsville. 109–110
West Branch of Susquehanna River, measurements of, at Allenwood, Pa. 225–226
at Williamsport, Pa..... 221–225
West Camden, N. Y,, water power at..... 109
West Canada Creek, New York, measurements of, at Middleville..... 155–157
at Twin Rock bridge 153–155
West Point, Ga., hydrographic work at.. 270–271
rating table for..... 322
West Troy, Mohawk River near, elevation of surface of 185, 193
fall of 198
West Troy Company's dam, New York, gages near, description of 193
Williamsport, Pa., hydrographic work at. 221–225
Williamstown, N. Y., water powers at 109
Willis Ferry, Georgia, hydrographic work at..... 263
Willowglen, N. Y., hydrographic work at..... 118–121, 122–126, 127–128
Willowvale, N. Y., water powers at 150
Wilkesbarre, Pa., hydrographic work at ... 220
Wilson's dam, New York, dimensions of... 54
hydrographic work at..... 54, 55, 56–57
Wissahickon Creek near Philadelphia, Pa., measurements of 218
Wood road bridge, New York, hydrographic work at 147–149
Woodbury, Ga., hydrographic work at... 265–266
rating table for..... 321
Woodcock, H. L., aid by 136
Woodstock, Md., hydrographic work at.... 228
rating table for..... 318
Woodstock, N. Y., water power at..... 62

Y.

Yadkin River at Salisbury, N. C., measurements of..... 246
rating table for..... 320
at Siloam, N. C., measurements of 245
Yazoo City, Miss., hydrographic work at. 287–288
Yazoo River at Yazoo City, Miss., measurements of..... 287–288
Yellow River at Almon, Ga., measurements of..... 261–262
rating table for..... 321
Yorkville, N. Y., hydrographic work at.. 150–151
Yosts, N. Y., gage at, description of 194
Mohawk River near, elevation of surface of..... 189, 193
fall of 201, 202
Youghiogheny River at Friendsville, Md., measurements of 289
rating table for..... 323
Young, W. W., aid by 16

1895.

Sixteenth Annual Report of the United States Geological Survey, 1894–95, Part II, Papers of an economic character, 1895; octavo, 598 pp.

Contains a paper on the public lands and their water supply, by F. H. Newell, illustrated by a large map showing the relative extent and location of the vacant public lands; also a report on the water resources of a portion of the Great Plains, by Rober Hay

A geological reconnoissance of northwestern Wyoming, by George H. Eldridge, 1894; octavo, 72 pp. Bulletin No. 119 of the United States Geological Survey.

Contains a description of the geologic structure of portions of the Big Horn Range and Big Horn Basin, especially with reference to the coal fields, and remarks upon the water supply and agricultural possibilities.

Report of progress of the division of hydrography for the calendar years 1893 and 1894, by F. H. Newell, 1895; octavo, 176 pp. Bulletin No. 131 of the United States Geological Survey.

Contains results of stream measurements at various points, mainly within the arid region, and records of wells in western Nebraska, western Kansas, and eastern Colorado.

1896.

Seventeenth Annual Report of the United States Geological Survey, 1895–96, Part II, Economic geology and hydrography, 1896; octavo, 864 pp.

Contains papers on "The underground water of the Arkansas Valley in eastern Colorado," by G. K. Gilbert; "The water resources of Illinois," by Frank Leverett, and "Preliminary report on the artesian waters of a portion of the Dakotas," by N. H. Darton.

Artesian-well prospects in the Atlantic Coastal Plain region, by N. H. Darton, 1896; octavo, 230 pp., 19 plates. Bulletin No. 138 of the United States Geological Survey.

Gives a description of the geologic conditions of the coastal region from Long Island, New York, to Georgia, and contains data relating to many of the deep wells.

Report of progress of the division of hydrography for the calendar year 1895, by F. H. Newell, hydrographer in charge, 1896; octavo, 356 pp. Bulletin No. 140 of the United States Geological Survey.

Contains a description of the instruments and methods employed in measuring streams and the results of hydrographic investigations in various parts of the United States.

1897.

Eighteenth Annual Report of the United States Geological Survey, 1896–97, Part IV, Hydrography, 1897; octavo, 756 pp.

Contains a "Report of progress of stream measurements for the calendar year 1896," by Arthur P. Davis; "The water resources of Indiana and Ohio," by Frank Leverett; "New developments in well boring and irrigation in South Dakota," by N. H. Darton, and "Reservoirs for irrigation," by J. D. Schuyler.

1899.

Nineteenth Annual Report of the United States Geological Survey, 1897–98, Part IV, Hydrography, 1899; octavo, 814 pp.

Contains a "Report of progress of stream measurements for the calendar year 1898," by F. H. Newell and others; "The rock waters of Ohio," by Edward Orton, and "A preliminary report on the geology and water resources of Nebraska west of the one hundred and third meridian," by N. H. Darton.

Part II of the Nineteenth Annual contains a paper on "Principles and conditions of the movements of ground water," by F. H. King, and one on "Theoretical investigation of the motion of ground waters," by C. S. Slichter.

1900.

Twentieth Annual Report of the United States Geological Survey, 1898–99, Part IV, Hydrography, 1900; octavo, 660 pp.

Contains a "Report of progress of stream measurements for the calendar year 1898," by F. H. Newell, and "Hydrography of Nicaragua," by A. P. Davis.

1901.

Twenty-first Annual Report of the United States Geological Survey, 1899–1900, Part IV, Hydrography, 1901; octavo, 768 pp.

Contains a "Report of progress of stream measurements for the calendar year 1899," by F. H. Newell; "Preliminary description of the geology and water resources of the southern half of the Black Hills and adjoining regions in South Dakota and Wyoming," by N. H. Darton, and "The High Plains and their utilization," by W. D. Johnson.

Such of the above papers as are published by the United States Geological Survey may be obtained on application until the edition is exhausted. Correspondence should be addressed to

The Director,
United States Geological Survey,
Washington, D. C.

WATER-SUPPLY AND IRRIGATION PAPERS.

1. Pumping water for irrigation, by Herbert M. Wilson, 1896.
2. Irrigation near Phoenix, Ariz., by Arthur P. Davis, 1897.
3. Sewage irrigation, by George W. Rafter, 1897.
4. A reconnoissance in southeastern Washington, by Israel C. Russell, 1897.
5. Irrigation practice on the Great Plains, by E. B. Cowgill, 1897.
6. Underground waters of southwestern Kansas, by Erasmus Haworth, 1897.
7. Seepage waters of northern Utah, by Samuel Fortier, 1897.
8. Windmills for irrigation, by E C. Murphy, 1897.
9. Irrigation near Greeley, Colo., by David Boyd, 1897.
10. Irrigation in Mesilla Valley, New Mexico, by F. C. Barker, 1898.
11. River heights for 1896, by Arthur P. Davis, 1897.
12. Water resources of southeastern Nebraska, by Nelson Horatio Darton, 1898.
13. Irrigation systems in Texas, by William Ferguson Hutson, 1898.
14. New tests of pumps and water lifts used in irrigation, by O. P. Hood, 1898.
15, 16. Operations at river stations, 1897, Parts I, II, 1898.
17. Irrigation near Bakersfield, Cal., by C. E. Grunsky, 1898.
18. Irrigation near Fresno, Cal., by C. E. Grunsky, 1898.
19. Irrigation near Merced, Cal., by C. E. Grunsky, 1899.
20. Experiments with windmills, by Thomas O. Perry, 1899.
21. Wells of northern Indiana, by Frank Leverett, 1899.
22. Sewage irrigation, Part II, by George W. Rafter, 1899.
23. Water-right problems of the Bighorn Mountains, by Elwood Mead, 1899.
24, 25. Water resources of the State of New York, Pts. I, II, by G. W. Rafter, 1899.
26. Wells of southern Indiana (continuation of No. 21), by Frank Leverett, 1899.
27, 28. Operations at river stations, 1898, Parts I, II, 1899.
29. Wells and windmills in Nebraska, by Erwin Hinckley Barbour, 1899.
30. Water resources of the lower peninsula of Michigan, by Alfred C. Lane, 1899.
31. Lower Michigan mineral waters, by Alfred C. Lane, 1899.
32. Water resources of Porto Rico, by H. M. Wilson, 1900.
33. Storage of water on Gila River, Arizona, by J. B. Lippincott, 1900.
34. Geology and water resources of southeastern S. Dak., by J. E. Todd, 1900.
35–39. Operations at river stations, 1899, Parts I–V, 1900.
40. The Austin dam, by Thomas U. Taylor, 1900.
41, 42. The windmill: its efficiency and use, Parts I, II, by E. C. Murphy, 1901.
43. Conveyance of water in irrigation canals, etc., by Samuel Fortier, 1901.
44. Profiles of rivers, by Henry Gannett, 1901.
45. Water storage on Cache Creek, California, by Albert E. Chandler, 1901.
46. Recon. of Kern and Yuba rivers, Cal., by F. H. Olmsted and M. Manson, 1901.
47–52. Operations at river stations, 1900, Parts I–VI, 1901.
53, 54. Geology and water sources Nez Perce Co., Idaho, Pts. I, II, by I. C. Russell.
55. Geology and water resources of Yakima Co., Wash., by G. O. Smith, 1901.
56. Methods of stream measurement, 1901.
57. Deep borings in United States, Part I, by N. H. Darton, 1902.
58. Water storage on Kings River, California, by J. B. Lippincott, 1902.
59, 60. Development and application of water in southern California. Pts. I, II, by J. B. Lippincott, 1902.
61. Deep borings in United States, Part II, by N. H. Darton, 1902.
62, 63. Hydrography of Southern Appalachian region, Pts. I, II, by H. A. Pressey.
64. Accuracy of stream measurements, by E. C. Murphy, 1902.
65, 66. Operations at river stations, 1901, Parts I, II, 1902.

Other papers are in preparation. The endeavor is made to send these pamphlets to persons who have assisted in their preparation by replies to inquiries or otherwise. Requests made for a certain paper are granted whenever practicable, but it is impossible to comply with general demands, such as to have all of the series sent. Application should be made either to members of Congress or to

THE DIRECTOR,
UNITED STATES GEOLOGICAL SURVEY,
WASHINGTON, D. C.

I 19.13/66
CLEMSON COLLEGE LIBRARY
GOVERMENT PUBLICATIONS

DEPARTMENT OF THE INTERIOR

WATER-SUPPLY

AND

IRRIGATION PAPERS

OF THE

UNITED STATES GEOLOGICAL SURVEY

No. 66

OPERATIONS AT RIVER STATIONS, 1901, PART II
(WEST OF MISSISSIPPI RIVER)

WASHINGTON
GOVERNMENT PRINTING OFFICE
1902

IRRIGATION REPORTS.

The following list contains titles and brief descriptions of the principal reports relating to water supply and irrigation prepared by the United Stated Geological Survey since 1890:

1890.

First Annual Report of the United States Irrigation Survey, 1890; octavo, 123 pp.

Printed as Part II, Irrigation, of the Tenth Annual Report of the United States Geological Survey, 1888-89. Contains a statement of the origin of the Irrigation Survey, a preliminary report on the organization and prosecution of the survey of the arid lands for purposes of irrigation, and report of work done during 1890.

1891.

Second Annual Report of the United States Irrigation Survey, 1891; octavo, 395 pp.

Published as Part II Irrigation, of the Eleventh Annual Report of the United States Geological Survey, 1889-90. Contains a description of the hydrography of the arid region and of the engineering operations carried on by the Irrigation Survey during 1890; also the statement of the Director of the Survey to the House Committee on Irrigation, and other papers, including a bibliography of irrigation literature. Illustrated by 30 plates and 4 figures.

Third Annual Report of the United States Irrigation Survey, 1891; octavo, 576 pp.

Printed as Part II of the Twelfth Annual Report of the United States Geological Survey, 1890-91. Contains "Report upon the location and survey of reservoir sites during the fiscal year ended June 30, 1891," by A. H. Thompson; "Hydrography of the arid regions," by F. H. Newell; "Irrigation in India," by Herbert M. Wilson. Illustrated by 93 plates and 190 figures.

Bulletins of the Eleventh Census of the United States upon irrigation, prepared by F. H. Newell, quarto.

No. 35, Irrigation in Arizona; No. 60. Irrigation in New Mexico; No. 85, Irrigation in Utah; No. 107, Irrigation in Wyoming; No. 153, Irrigation in Montana; No. 157, Irrigation in Idaho; No. 163, Irrigation in Nevada; No. 178, Irrigation in Oregon; No. 193, Artesian wells for irrigation; No. 198, Irrigation in Washington.

1892.

Irrigation of western United States, by F. H. Newell; extra census bulletin No. 23, September 9, 1892; quarto, 22 pp.

Contains tabulations showing the total number, average size, etc., of irrigated holdings, the total area and average size of irrigated farms in the subhumid regions, the percentage of number of farms irrigated, character of crops, value of irrigated lands, the average cost of irrigation, the investment and profits, together with a résumé of the water supply and a description of irrigation by artesian wells. Illustrated by colored maps showing the location and relative extent of the irrigated areas.

1893.

Thirteenth Annual Report of the United States Geological Survey, 1891-92, Part III, Irrigation, 1893; octavo, 486 pp.

Consists of three papers: "Water supply for irrigation," by F. H. Newell; "American irrigation engineering" and "Engineering results of the Irrigation Survey," by Herbert M. Wilson; and "Construction of topographic maps and selection and survey of reservoir sites," by A. H. Thompson. Illustrated by 77 plates and 119 figures.

A geological reconnoissance in central Washington, by Israel Cook Russell, 1893; octavo, 108 pp., 12 plates. Bulletin No. 108 of the United States Geological Survey.

Contains a description of the geologic structure in and adjacent to the drainage basin of Yakima River and the great plains of the Columbia to the east of this area, with special reference to the occurrence of artesian waters.

1894.

Report on agriculture by irrigation in the western part of the United States at the Eleventh Census, 1890, F. H. Newell, 1894; quarto, 283 pp.

Consists of a general description of the condition of irrigation in the United States, the area irrigated, cost of works, their value and profits; also describes the water supply, the value of water, of artesian wells, reservoirs, and other details; then takes up each State and Territory in order, giving a general description of the condition of agriculture by irrigation, and discusses the physical conditions and local peculiarities in each county.

Fourteenth Annual Report of the United States Geological Survey, 1892-93; Part II, Accompanying papers, 1894; octavo, 597 pp.

Contains papers on "Potable waters of the eastern United States," by W. J. McGee; "Natural mineral waters of the United States," by A. C. Peale; and "Results of stream measurements," by F. H. Newell. Illustrated by maps and diagrams.

(Continued on third page of cover.)

DEPARTMENT OF THE INTERIOR

WATER-SUPPLY

AND

IRRIGATION PAPERS

OF THE

UNITED STATES GEOLOGICAL SURVEY

No. 66

WASHINGTON
GOVERNMENT PRINTING OFFICE
1902

UNITED STATES GEOLOGICAL SURVEY

CHARLES D. WALCOTT, DIRECTOR

OPERATIONS AT RIVER STATIONS, 1901

A REPORT OF THE

DIVISION OF HYDROGRAPHY

OF THE

UNITED STATES GEOLOGICAL SURVEY

PART II—(WEST OF MISSISSIPPI RIVER)

WASHINGTON
GOVERNMENT PRINTING OFFICE
1902

CONTENTS.

	Page.
Hudson Bay drainage	9
Red River of the North	9
Red River at Moorhead, Minn	9
Red Lake River at Crookston, Minn	10
Red River at Grand Forks, N. Dak	11
Red River at Pembina, N. Dak	12
Red River at Emerson, Manitoba	13
Devils Lake at Devils Lake, N. Dak	14
St. Mary River at Main, Mont	14
List of miscellaneous measurements of tributaries of St. Mary River, Montana	15
Upper Missouri River drainage	15
Milk River at Havre, Mont	15
West Gallatin River near Salesville, Mont	16
Gallatin River at Logan, Mont	17
Madison River near Redbluff, Mont	18
Jefferson River at Sappington, Mont	19
Missouri River near Townsend, Mont	20
Crow Creek near Radersburg, Mont	21
Yellowstone River near Livingston, Mont	22
List of miscellaneous discharge measurements in Missouri River Basin in Montana	23
Bighorn River near Thermopolis, Wyo	23
Miscellaneous measurements of Shell Creek, Wyoming, and tributaries	23
Big Sioux River near Watertown, S. Dak	24
Big Sioux River near Sioux Falls, S. Dak	24
Niobrara River at Valentine, Nebr	25
Platte River drainage	26
Medicine Bow River at Medicine Bow, Wyo	26
North Platte River near Guernsey, Wyo	27
North Platte River at Mitchell, Nebr	28
North Platte River at North Platte, Nebr	28
South Fork of South Platte River at Cheesman, Colo	29
South Platte River at Denver, Colo	30
Bear Creek near Morrison, Colo	31
Clear Creek at Forkscreek, Colo	31
South Boulder Creek near Marshall, Colo	32
Boulder Creek near Boulder, Colo	33
St. Vrain Creek near Lyons, Colo	34
Big Thompson Creek near Arkins, Colo	36
Cache la Poudre River near Fort Collins, Colo	36
South Platte River at Kersey, Colo	37
Loup River near Columbus, Nebr	38
Platte River near Columbus, Nebr	39
Elkhorn River near Norfolk, Nebr	40
Elkhorn River near Arlington, Nebr	40
Kansas River drainage	41
Republican River near Superior, Nebr	41
Miscellaneous discharge measurements of streams in Nebraska	43
Republican River at Junction, Kans	43
Solomon River near Niles, Kans	44
Saline River near Salina, Kans	44
Smoky Hill River at Ellsworth, Kans	45

Kansas River drainage—Continued. Page.
Blue River near Manhattan, Kans 46
Kansas River at Lecompton, Kans 46
Arkansas River drainage 47
Arkansas River at Granite, Colo 47
Arkansas River at Salida, Colo 47
Arkansas River near Canyon, Colo 48
Arkansas River at Pueblo, Colo 49
Arkansas River near Nepesta, Colo 50
Arkansas River near Rockyford, Colo 51
Arkansas River near La Junta, Colo 52
Arkansas River at Prowers, Colo 53
Arkansas River at Amity Canal head gates, Colorado 53
Arkansas River near Granada, Colo 54
Arkansas River near Barton, Colo 54
List of miscellaneous discharge measurements in Mississippi River basin in Colorado 55
Arkansas River at Hutchinson, Kans 56
Verdigris River near Liberty, Kans 56
Neosho River near Iola, Kans 57
Western Gulf drainage 58
Brazos River at Waco, Tex 58
Bosque River, Texas 59
Sulphur Fork of Lampasas River, Texas 60
Solado River, Texas 60
Leon River, Texas 60
Little River, Texas 60
Concho River, Texas 61
Mill Creek, Texas 62
Llano River, Texas 62
Guadalupe River, Texas 62
Carrizo Springs, Texas 63
Colorado River at Austin, Tex 64
Rio Grande near Del Norte, Colo 65
Rio Grande at Cenicero, Colo 65
Rio Grande at Embudo, N. Mex 66
Rio Grande at Rio Grande, N. Mex 67
Rio Grande near San Marcial, N. Mex 68
Rio Grande near El Paso, Tex 70
Lower Rio Grande 71
Rio Grande near Fort Hancock, Tex 71
Rio Grande above Presidio, Tex 72
Rio Grande below Presidio, Tex 74
Rio Grande near Langtry, Tex 75
Pecos River near Pecos, Tex 76
Pecos River near Moorhead, Tex 77
Devils River at Devils River, Tex 79
Rio Grande near Devils River, Tex 80
Rio Grande near Eagle Pass, Tex 81
Colorado River drainage 82
Green River at Greenriver, Wyo 82
Ashley Creek near Vernal, Utah 83
Uinta River near Whiterocks, Utah 84
Whiterocks River near Whiterocks, Utah 85
Uinta River at Fort Duchesne, Utah 85

Colorado River drainage—Continued. Page.
Uinta River at Ouray School, Utah 86
Lake Creek, Utah, near mouth 87
Duchesne River at Price road bridge, Utah 88
Yampa River, Colorado 89
Yampa River at Craig, Colo 90
White River, Colorado 91
White River at Meeker, Colo 91
Grand River at Glenwood Springs, Colo 92
Gunnison River at Iola, Colo 93
Gunnison River at Whitewater, Colo 94
Dolores River at Dolores, Colo 95
Los Pinos River at Ignacio, Colo 95
Florida River near Durango, Colo 96
Animas River at Durango, Colo 97
Mancos River at Mancos, Colo 97
List of miscellaneous discharge measurements in Colorado River Basin in Colorado 98
Gila River at San Carlos, Ariz 98
Salt River at reservoir site, Arizona 99
Tonto Creek near Livingston, Ariz 100
Salt River at McDowell, Ariz 101
Verde River near McDowell, Ariz 102
Colorado River at Yuma, Ariz 104
Interior Basin drainage 104
Humboldt River near Elko, Nev 104
South Fork of Humboldt River at Mason's ranch, Nevada 105
Humboldt River near Golconda, Nev 106
Humboldt River near Oreana, Nev 107
East Fork of Carson River near Gardnerville, Nev 108
West Fork of Carson River at Woodfords, Cal 109
Carson River near Empire, Nev 110
Truckee River at Tahoe, Cal 111
Truckee River at Nevada-California State line 112
Truckee River at Vista, Nev 113
Steamboat Creek at Steamboat Springs, Nevada 114
Willow Creek near Standish, Cal 115
Susan River near Susanville, Cal 115
Bear River at Battlecreek, Idaho 117
Cub River at Franklin, Idaho 118
Logan River at Logan, Utah 118
Blacksmith Fork at Hyrum, Utah 119
Bear River near Collinston, Utah 120
Ogden River at Ogden, Utah 121
Weber River near Uinta, Utah 122
Spanish Fork near Mapleton, Utah 122
Provo River near Provo, Utah 123
American Fork near American Fork, Utah 124
Salina Creek near Salina, Utah 124
San Pitch River near Gunnison, Utah 125
Sevier River near Gunnison, Utah 126
Columbia River drainage 126
Snake River at Montgomery Ferry, Idaho 126
Bruneau River near Grandview, Idaho 127
Boise River near Boise, Idaho 128

Columbia River drainage—Continued. Page.
Weiser River near Weiser, Idaho 129
Blackfoot River near Bonner, Mont 130
Missoula River at Missoula, Mont 131
Bitterroot River at Missoula, Mont 131
Flathead Lake at Polson, Mont 132
Spokane River at Spokane, Wash 133
Naches River near North Yakima, Wash 133
Tieton River, Washington 134
Yakima River at Union Gap, Wash 135
Yakima River at Kiona, Wash 136
Palouse River near Hooper, Wash 136
Umatilla River at Gibbon, Oreg 137
White River near Buckley, Wash 138
Northern Pacific coast drainage 138
Dungeness River at Dungeness, Wash 138
Elwha River at McDonald, Wash 139
Kalawa River near Forks, Wash 140
Soleduck River near Quillayute, Wash 141
Miscellaneous discharge measurements in northwestern Washington 142
San Francisco Bay drainage 142
Sacramento River at Jellys Ferry, Cal 142
Stony Creek near Fruto, Cal 143
Cache Creek near Lower Lake, Cal 144
Mokelumne River at Electra, Cal 145
Stanislaus River near Oakdale, Cal 146
Tuolumne River at Hetch Hetchy Valley dam site, California 146
Eleanor Creek at Eleanor trail crossing, California 147
Cherry River at Eleanor trail crossing, California 148
Tuolumne River at Lagrange, Cal 149
Lagrange Ditch and Hydraulic Mining Company's canal 149
Turlock Canal 150
Merced River above Merced Falls, Cal 150
San Joaquin River at Herndon, Cal 151
King River near Red Mountain, California 152
King River near Kingsburg, Cal 153
Southern California drainage 154
Nacimiento Creek near Bryson, Cal 154
San Antonio Creek near Jolon, Cal 154
San Lorenzo Creek near King City, Cal 155
Arroyo Seco near Piney, Cal 156
Salinas River near Salinas, Cal 156
Tule River near Portersville, Cal 157
Kern River near Bakersfield, Cal 158
Mohave River at Victorville, Cal 159
Los Angeles River at the Narrows, California 160
Arroyo Seco near Los Angeles, Cal 161
San Gabriel River above Azusa, Cal 161
Lytle Creek at headgates of Rialto canals, California 162
Santa Ana River below Warmsprings, Cal 163
Mill Creek canals at Crafton headworks, California 166
Sweetwater River at Sweetwater dam, California 166
Miscellaneous discharge measurements in California 167
Precipitation on mountains in southern California 168
Rating tables 170
Index 179

OPERATIONS AT RIVER STATIONS, 1901.

PART II.—(WEST OF MISSISSIPPI RIVER).[a]

HUDSON BAY DRAINAGE.

RED RIVER OF THE NORTH.

This river drains a large watershed in the United States, covering portions of Minnesota and North and South Dakota, characterized by a level topography, broken up in places by moraines and other glacial deposits. The major part is prairie, and its eastern half has an abundance of lakes and some woods. The main river flows nearly due north, cutting a deep channel in its broad level valley, and is subject to sudden rises caused by heavy spring rains, entailing frequently considerable loss of life and property. Gaging stations were established during 1901 by Charles M. Hall, professor of geology at the North Dakota Agricultural College, at several points along the Red River of the North and on Red Lake River, its principal tributary, for the purpose of studying the flow of the river in connection with problems relating to storage of flood waters for use in furnishing power, water for irrigation and domestic supply. The valley of Red River comprises about 9,000,000 acres of excellent agricultural lands which to a large extent still await settlement. A number of water powers have been developed during recent years on the tributaries entering from both sides.

RED RIVER AT MOORHEAD, MINN.

This station was established by C. M. Hall May 27, 1901, and is located at the bridge connecting Front street, Fargo, N. Dak., and Main street, Moorhead, Minn. The gage consists of a board 1 by 8 inches, painted white, graduated to feet and tenths in black, and attached to the east side of the breakwater for the center pier of the bridge. The zero of the gage is 44.45 feet below the top of the plank walk of the bridge over the gage and is 860.9 feet above sea level, the elevation having been determined by leveling from top of rail of Northern Pacific station, Moorhead, Minn. The danger line is at 26.5 feet. Above the station the river curves to the west. The west bank is high and steep; the east bank low and subject to overflow at times

[a] Continued from Water-Supply Paper No. 65.

of high water. Measurements are made from the bridge. The river bed consists of soft mud. The observer is H. W. Grasse, United States Weather Bureau, Moorhead, Minn.

The following measurements were made at this station by C. M. Hall. The discharges are too large, the velocities having been determined at two-fifths depth.

July 23, 1900: Low water; discharge, 109 second-feet.
May 4, 1901: Gage height, 8.35 feet; discharge, 698 second-feet.
June 14, 1901: Gage height, 8.25 feet: discharge, 554 second-feet.
July 15, 1901: Gage height, 8.45 feet; discharge, 620 second-feet.

Daily gage height, in feet, of Red River at Moorhead, Minn., for 1901.

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	7.80	8.00	8.30	7.70	7.60	7.70	7.60
2	.....	7.80	8.00	8.20	7.70	7.60	7.60	7.60
3	.....	7.80	8.10	8.20	7.70	7.60	7.50	(a)
4	.....	7.90	8.20	8.20	7.70	7.60	7.30	.....
5	.....	7.90	9.00	8.20	7.70	7.60	7.00	.....
6	.....	7.90	8.80	8.20	7.60	7.60	6.80	.....
7	.....	7.90	8.60	8.20	7.60	7.60	7.00	.....
8	.....	7.90	8.60	8.20	7.60	7.70	7.20	.....
9	.....	8.00	9.10	8.20	7.60	7.80	7.40	.....
10	.....	8.00	9.00	8.20	7.60	7.90	7.60	.....
11	.....	8.10	8.80	8.20	7.60	8.00	7.60	.....
12	.....	8.10	8.60	8.20	1.60	8.10	7.70	.....
13	.....	8.10	8.60	8.20	7.60	8.10	7.70	.....
14	.....	8.20	8.50	8.20	7.60	8.00	7.80	.....
15	.....	8.20	8.40	8.20	7.60	8.00	8.00	.....
16	.....	8.20	8.30	8.20	7.60	7.90	8.00	.....
17	.....	8.30	8.30	8.20	7.60	7.90	7.80	.....
18	.....	8.30	8.20	8.20	7.60	7.80	7.60	.....
19	.....	8.40	8.20	8.10	7.60	7.80	7.60	.....
20	.....	8.40	8.10	8.10	7.60	7.70	7.60	.....
21	.....	8.50	8.00	8.10	7.60	7.70	7.60	.....
22	.....	8.40	8.00	8.00	7.60	7.60	7.60	.....
23	.....	8.30	7.90	8.00	7.60	7.60	7.60	.....
24	.....	8.20	7.80	8.00	7.50	7.60	7.60	.....
25	.....	8.10	7.80	8.00	7.50	7.60	7.60	.....
26	.....	8.10	7.80	8.00	7.60	7.60	7.60	.....
27	7.90	8.20	7.90	8.00	7.70	7.60	7.60	.....
28	7.90	8.10	8.00	8.00	7.70	7.60	7.60	.....
29	7.90	8.00	8.20	7.80	7.70	7.70	7.60	.....
30	7.90	8.00	8.30	7.80	7.70	7.80	7.60	.....
31	7.80	.....	8.40	7.80	.....	7.80	7.60	.....

[a] River frozen.

RED LAKE RIVER AT CROOKSTON, MINN.

This station was established by C. M. Hall May 19, 1901. It is located at the bridge connecting Robert street and St. Paul street, which is known as the Sampson addition bridge. The gage consists of a weight attached to a woven steel-wire rope which plays over a pulley attached to the center of the single-span bridge. Readings are made on a board 1 by 6 inches, painted white, graduated to feet and tenths, and attached to the east railing of the bridge. A similar gage board nailed to one of the south piers of the bridge is used for reading high-water stages. The zero of the gage is 820.07 feet above sea level and 9.8 feet below the bench mark, which is marked by one 20-penny and three 8-penny nails driven into the east end of the breakwater under the north end of the bridge.

The observer is John F. Fournet, Crookston, Minn. During 1901 the following measurements were made by C. M. Hall. With the exception of the last measurement, the discharges are too high, velocities having been determined at two-fifths depths.

May 18: Gage height, 8.42 feet; discharge, 3,859 second-feet.
May 30: Gage height, 6.78 feet; discharge, 2,241 second-feet.
June 17: Gage height, 7.53 feet; discharge, 3,026 second-feet.
October 16: Gage height, 6.10 feet; discharge, 1,755 second-feet.

Daily gage height, in feet, of Red Lake River at Crookston, Minn., for 1901.

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	.....	6.40	8.25	6.80	4.95	5.45	5.95
2	.....	6.32	8.42	6.80	4.95	5.45	5.90
3	.....	6.40	8.47	6.25	4.90	5.30	6.08
4	.....	7.05	8.50	6.40	4.95	5.50	6.03
5	.....	6.92	9.30	6.55	5.01	5.45	6.00
6	.....	7.15	10.39	6.45	4.98	5.48	5.59
7	.....	7.12	11.60	6.45	4.95	5.50	5.42
8	.....	6.95	11.60	5.65	4.95	5.45	5.30
9	.....	6.84	11.10	6.15	5.05	5.45	5.15
10	.....	6.85	10.55	6.10	5.15	5.40	5.15
11	.....	7.00	10.30	6.05	5.05	5.25	5.12
12	.....	6.92	9.70	6.50	5.25	5.15	5.08
13	.....	6.55	9.20	5.50	5.30	5.00	5.00
14	.....	7.40	8.80	5.50	5.50	4.98	4.95
15	.....	7.00	8.65	5.55	5.45	5.00	4.98
16	.....	7.01	8.60	5.85	5.40	6.01	4.96
17	.....	7.45	8.43	6.00	5.39	6.05	4.95
18	.....	7.90	8.50	5.40	5.45	6.05	4.90
19	8.13	7.80	8.20	5.55	5.50	6.10	4.93
20	8.25	7.75	7.95	6.40	5.52	6.12	4.90
21	7.85	7.83	8.05	5.90	5.49	6.15	4.88
22	7.95	7.88	7.85	7.80	5.50	6.20	4.85
23	7.75	7.85	7.80	6.10	5.40	6.18	4.85
24	7.25	7.55	7.65	6.05	5.55	6.12	4.90
25	([a])	7.49	7.40	6.05	6.80	6.10	4.90
26	([a])	10.20	6.95	6.45	6.85	6.05	4.85
27	([a])	9.30	6.85	5.95	5.65	6.02	4.88
28	([a])	9.40	6.90	5.95	5.63	6.00	4.90
29	([a])	8.80	6.90	5.90	5.55	5.95	4.92
30	6.78	8.60	6.87	5.80	5.50	5.90	4.96
31	6.65	.....	6.85	5.65	.....	6.00	.....

[a] River low—no water around gage.

RED RIVER AT GRAND FORKS, N. DAK.

This station was established by C. M. Hall May 26, 1901, and is located at the Northern Pacific Railway bridge crossing the river at Grand Forks, N. Dak. The gage consists of a board 1 by 8 inches, painted white, graduated to feet and tenths in black, and attached to the north end of the breakwater for the center pier of the bridge. The zero of the gage was placed 5 feet below the zero of the United States engineers' gage attached to the same breakwater, and is 779.9 feet above sea according to leveling done by the Corps of Engineers, United States Army. The danger line is at 40 feet. The channel is straight above the station. The bed of the river is composed of mud and fine sand and is changeable; the water is usually heavily laden with sediment from Red Lake River, which enters three-fourths of a mile above the station. Measurements are made from a rowboat about 150 yards below the gage. The observer is John F. Hayes,

watchman for the United States engineers' boats, Grand Forks, N. Dak.

The following measurements were made by C. M. Hall in 1901. The discharges are too large, the velocities having been determined at two-fifths depth.

May 24: Gage height, 10.2 feet; discharge, 3,360 second-feet.
May 31: Gage height, 9.5 feet; discharge, 3,058 second-feet.
June 17: Gage height, 9.7 feet; discharge, 3,354 second-feet.
July 13: Gage height, 19.3 feet; discharge, 10,074 second-feet.

Daily gage height, in feet, of Red River at Grand Forks, N. Dak., for 1901.

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	.....	9.25	14.48	10.83	7.63	6.88	8.15
2	.....	9.00	14.25	10.48	7.48	6.95	8.20
3	.....	8.95	14.20	10.35	7.20	7.03	8.25
4	.....	9.03	14.20	10.15	7.15	7.05	8.10
5	.....	9.18	15.00	9.85	7.30	7.05	6.75
6	.....	9.50	16.88	9.75	7.20	7.05	7.10
7	.....	9.35	19.20	9.50	7.35	7.10	6.50
8	.....	9.40	20.80	9.28	7.18	7.05	6.40
9	.....	9.20	21.48	9.00	6.85	6.98	6.50
10	.....	9.25	21.25	8.85	7.05	7.08	7.28
11	.....	9.20	20.58	8.85	7.15	7.25	7.65
12	.....	7.30	20.05	8.90	6.90	7.45	7.85
13	.....	9.00	19.15	8.93	6.70	7.75	7.45
14	.....	9.05	18.45	9.00	6.93	7.90	7.55
15	.....	9.50	17.00	8.70	6.85	8.78	7.35
16	.....	9.60	16.90	8.45	6.70	8.65	7.00
17	.....	9.70	16.18	8.48	6.63	8.85	.....
18	.....	10.00	15.40	8.63	6.65	8.85	.....
19	.....	10.40	14.55	8.45	6.60	8.65	.....
20	.....	10.43	13.78	8.20	6.80	8.65	.....
21	.....	10.58	13.10	8.43	6.43	8.60	.....
22	.....	10.65	12.63	8.45	6.43	8.68	.....
23	.....	10.83	12.30	8.25	6.35	8.60	.....
24	.....	10.90	11.95	8.33	6.25	8.55	.....
25	.....	10.93	11.85	8.20	6.33	8.15	.....
26	9.60	11.18	11.73	8.15	6.53	8.88	.....
27	9.43	14.75	11.53	8.20	6.80	8.10	.....
28	8.40	15.55	11.08	8.15	6.75	8.10	.....
29	9.43	15.45	11.10	8.05	6.70	8.05	.....
30	9.60	14.90	11.10	7.90	6.87	8.00	.....
31	9.50	.....	11.08	7.80	.....	7.98	.....

RED RIVER AT PEMBINA, N. DAK.

This station was established by C. M. Hall June 18, 1901, and is located at the ferry between Pembina, N. Dak., and St. Vincent, Minn., one-half mile below the mouth of Pembina River. The gage consists of a board 1 by 6 inches, painted white, graduated to feet and tenths, and attached to a 4 by 4 inch pile driven into the bed of the river. The high-water gage consists of a similar pile and board placed higher up on the west bank. The bed of the river consists of hard clay, while the banks are of soft clay, the west bank being high and steep. Measurements are made from a rowboat along the line of the ferry cable. A United States Geological Survey bench mark placed on the north side of the road leading to the ferry on the highest point of the west bank of the river has an elevation of 795.73 feet above sea level. The zero of the gage is 46.126 feet below the bench mark, or 649.604 feet above sea level. The observer is John Meldrum, keeper

of ferry, Pembina, N. Dak. The station was used during the open season of 1901, but on account of the difficulty in keeping the gage in place it has been removed to Emerson station, 2 miles north.

The following measurements were made in 1901 by C. M. Hall. These measurements give too high a discharge, the velocities having been determined at two-fifths depth.

June 19: Gage height, 10.95 feet; discharge, 3,930 second-feet.
July 12: Gage height, 21.92 feet; discharge, 14,134 second-feet.

Daily gage height, in feet, of Red River at Pembina, N. Dak., for 1901.

Day.	June.	July.	Aug.	Sept.	Oct.	Nov.
1		14.90	10.55	7.93	6.70	7.88
2		15.00	10.93	7.83	6.75	7.78
3		14.90	10.78	7.65	6.78	7.70
4		14.75	10.58	7.58	6.80	7.85
5		14.80	10.33	7.35	6.80	7.85
6		15.00	10.05	7.18	6.88	8.15
7		15.85	9.85	7.08	6.90	9.15
8		17.60	9.65	7.05	6.90	7.83
9		19.25	9.53	7.05	6.98	7.58
10		20.50	9.38	7.05	6.93	7.28
11		21.40	9.25	7.00	6.95	7.08
12		21.92	9.05	6.93	7.03	7.00
13		21.70	8.85	6.90	7.15	6.98
14		22.62	8.68	6.90	7.33	7.05
15		21.83	8.68	6.83	7.45	7.18
16		21.10	8.73	6.78	7.70	7.25
17		20.15	8.68	6.73	8.05	.....
18	10.60	19.10	8.58	6.78	8.35	.....
19	11.00	18.10	8.48	6.70	8.55	.....
20	11.45	17.05	8.38	6.68	8.60	.....
21	11.85	15.95	8.38	6.58	8.60	.....
22	12.35	15.05	8.38	6.58	8.55	.....
23	12.70	14.25	8.33	6.50	8.50	.....
24	12.85	13.55	8.30	6.50	8.43	.....
25	12.85	12.90	8.30	6.55	8.33	.....
26	12.85	12.38	8.28	6.50	8.30	.....
27	12.85	12.10	8.20	6.50	8.28	.....
28	13.50	11.83	8.20	6.50	8.08	.....
29	14.60	11.60	8.10	6.53	8.00	.....
30	14.90	11.40	8.08	6.65	7.95	.....
31	.....	11.18	8.05	.....	7.90	.....

RED RIVER AT EMERSON, MANITOBA.

This station was established by C. M. Hall, July 26, 1900, and is located at the Emerson railway and traffic bridge one-half mile north of the international boundary line at Emerson, Manitoba. It consists of a board 1 by 6 inches, painted white, grooved, graduated to feet and tenths, and attached to the east side of the breakwater for the center stone pier of the bridge. The zero of the gage is 46.5 feet below a steel beam of the bridge directly over the gage, and its elevation is 747.915 feet above sea level. The bed and the banks of the stream consist of clay. Measurements are usually made from a row-boat. The observer for 1902 is Robert Rossall, Emerson. The readings here were not kept up in 1901 while the gage was maintained at Pembina station, but were resumed when the ice broke up in 1902, the Pembina station having been discontinued.

The following measurements were made by C. M. Hall; the dis-

charges given are too high, the velocities having been determined at two-fifths depth:

July 6, 1900: Gage height, 2.15 feet; discharge, 984 second-feet.
June 1, 1901: Gage height, 7 feet; discharge, 3,595 second-feet.

DEVILS LAKE AT DEVILS LAKE, N. DAK.

This station was established by C. M. Hall, June 8, 1901, and is located at the boat landing at the Chautauqua grounds, 4 miles southwest of Devils Lake station, N. Dak. The object of maintaining a gage record on Devils Lake is to ascertain the fluctuations in its water level, which, during past years, has been steadily falling, the drop in the last nineteen years amounting to as much as 10 or 12 feet. The lake has no regular outlets and its waters are salt. It is hoped that a study of such records will lead to important conclusions relating to evaporation from the lake surface. The gage consists of a 2 by 8 inch plank, painted white, grooved, and graduated to feet and tenths, and attached to the middle of the north row of piles of the Chautauqua boat landing.

A United States Geological Survey bench mark is placed on the shore of the lake 3 rods west of the Chautauqua gate, which opens to a boat landing. It corresponds to the height of the lake in June, 1879, which was preserved by a hardwood post driven level with the water by Capt. E. E. Heerman. The bench mark is 1,439.08 feet above sea level. The zero of the gage is 22.464 feet below the bench mark. The observer is Capt. E. E. Heerman.

The following gage readings were taken during 1901:

Gage heights of Devils Lake in 1901.

	Feet.		Feet.
June 7	12.15	September 14	11.90
June 8	12.40	September 19	11.65
June 23	12.35	September 26	12.15
June 27	12.25	October 8	12.10
August 17	12.05	October 21	12.05

ST. MARY RIVER AT MAIN, MONT.

This station was established by C. C. Babb, July 14, 1901, and is located at the highway bridge at Main, about 1 mile below the mouth of Swiftcurrent Creek. During 1900 a number of measurements were made at this point, and a temporary bench mark was established, consisting of a notch in the timber on the downstream side of the right abutment. When the station was established the height of this notch on the gage was found to be 1.60 feet. The rod is vertical and is spiked to the timbers on the lower end of the left abutment. Bench mark No. 1 is a nail in the blaze of a cottonwood tree 15 feet northwest of the rod, and is at an elevation of 4,418.49 feet. Bench mark

No. 2 is a temporary bench mark of the topographic division, consisting of a stone in the road 400 feet northwest of the bridge, at an elevation of 4,419 feet. The elevation of the zero of the rod is 4,411.72. The channel above and below the station is straight, and the velocity of the water is swift. The right bank is high, and the left bank is low and liable to overflow. A short distance west of the bridge is a slough which carries a certain amount of water during flood stages, and, therefore, has to be gaged on such occasions. The bed of the stream consists of gravel and bowlders.

List of discharge measurements of St. Mary River at Main, Mont.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1900.	*Feet.*	*Sec.-ft.*	1901.	*Feet.*	*Sec.-ft.*
June 16[a]		750	August 2	2.15	1,479
June 18	2.90	2,294	October 9	.80	424
August 6	1.60	750	October 30	.53	311
October 1	1.10	552	November 5	.42	285
1901.					
July 20	2.60	1,827			

[a] At outlet of lake.

Daily gage height, in feet, of St. Mary River at Main, Mont., for 1901.

Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1		2.30	1.35	0.90	0.55	0.40	17	2.70	1.60	1.20	0.75	0.40	0.20
2		2.25	1.35	.90	.55	.40	18	2.60	1.60	1.15	.75	.40	.15
3		2.10	1.30	.85	.50	.40	19	2.60	1.55	1.15	.75	.40	.15
4		2.05	1.30	.80	.50	.35	20	2.60	1.55	1.15	.75	.35	.15
5		2.00	1.30	.80	.40	.35	21	2.55	1.55	1.10	.70	.35	.15
6		1.95	1.35	.80	.40	.35	22	2.55	1.50	1.10	.70	.35	.10
7		1.95	1.40	.80	.40	.30	23	2.55	1.50	1.05	.70	.35	.10
8		1.90	1.40	.80	.35	.30	24	2.50	1.50	1.00	.70	.40	.10
9		1.90	1.35	.80	.40	.30	25	2.55	1.45	1.00	.65	.40	.10
10		1.85	1.25	.80	.50	.30	26	2.55	1.45	1.00	.65	.40	.05
11		1.85	1.20	.80	.55	.25	27	2.50	1.45	1.00	.60	.45	.05
12		1.80	1.15	.80	.60	.25	28	2.50	1.40	.95	.60	.45	.05
13		1.75	1.15	.80	.55	.25	29	2.45	1.40	.95	.60	.45	.05
14	2.93	1.75	1.15	.75	.55	.20	30	2.35	1.40	.95	.55	.45	.05
15	2.83	1.65	1.15	.75	.50	.20	31	2.30	1.35		.55		.05
16	2.80	1.65	1.20	.75	.40	.20							

List of miscellaneous discharge measurements of tributaries of St. Mary River, Montana, for 1901.

Date.	Stream.	Locality.	Hydrographer.	Discharge.
				Sec.-ft.
Oct. 9	Swiftcurrent Creek	Near Main	C. C. Babb	188
Oct. 30	do	do	L. V. Branch	123
Nov. 5	Kennedy Creek	1 mile above mouth	G. H. Matthes	55

UPPER MISSOURI DRAINAGE.

MILK RIVER AT HAVRE, MONT.

This station was established by C. C. Babb in May, 1898, and is described in Water-Supply Paper No. 49, page 267. Results of

measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 288. During 1901 the following measurements were made by L. H. Ling under the direction of Samuel Fortier:

List of discharge measurements of Milk River at Havre, Mont.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1901.	*Feet.*	*Sec.-ft.*	1901.	*Feet.*	*Sec.-ft.*
March 9	5.00	1,016	June 14	5.20	1,225
March 11	4.90	1,006	July 2	3.60	341
March 14	4.35	664	July 8	3.10	204
March 15	5.15	1,272	July 16	3.00	147
March 18	4.70	818	July 27	2.40	68
March 23	3.90	511	August 8	2.20	37
March 28	3.80	458	August 19	2.00	23
April 3	3.10	280	August 29	1.70	13
April 5	3.05	300	September 7	1.90	17
April 16	2.80	199	September 21	2.60	100
April 24	2.70	198	September 27	2.60	96
May 2	3.10	304	October 9	2.50	102
May 4	6.20	2,577	October 16	2.50	80
May 6	5.00	1,162	October 26	2.50	72
May 23	4.30	836	November 5	2.35	63
June 8	3.40	261	November 12	2.60	82
June 12	4.50	893	November 20	2.50	71

Daily gage height, in feet, of Milk River at Havre, Mont., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	(a)	(a)	5.45	3.10	3.10	4.30	3.60	2.40	1.60	2.50	2.50	2.60
2	(a)	(a)	7.45	3.10	3.10	3.80	3.60	2.30	1.60	2.50	2.50	2.60
3	(a)	(a)	6.55	3.10	3.10	3.40	3.40	2.20	1.50	2.50	2.40	2.80
4	(a)	(a)	5.60	2.90	5.96	3.40	3.30	2.20	1.50	2.50	2.40	2.80
5	(a)	(a)	5.20	3.00	5.50	3.40	3.30	2.20	1.50	2.40	2.40	3.20
6	(a)	(a)	5.00	3.00	5.00	3.40	3.20	2.20	1.60	2.40	2.40	3.30
7	(a)	(a)	6.20	2.90	5.30	3.40	3.10	2.20	1.90	2.50	(a)	3.30
8	(a)	(a)	6.50	2.70	4.40	3.40	3.10	2.20	2.00	2.50	2.50	3.30
9	(a)	(a)	5.20	2.70	4.40	3.30	3.40	2.20	2.00	2.50	2.50	(a)
10	(a)	(a)	5.00	2.70	4.00	3.30	3.60	2.20	2.00	2.60	2.50	(a)
11	(a)	(a)	4.90	2.60	3.70	3.40	3.90	2.20	2.10	2.60	2.50	(a)
12	(a)	(a)	4.90	2.60	3.40	4.30	3.50	2.20	2.30	2.60	2.60	(a)
13	(a)	(a)	5.00	2.60	3.40	5.00	3.20	2.10	2.30	2.60	2.50	(a)
14	(a)	(a)	4.95	2.60	3.40	5.20	3.10	2.00	2.00	2.60	2.50	(a)
15	(a)	(a)	5.15	2.40	3.20	4.50	3.10	2.00	2.50	2.60	2.50	(a)
16	(a)	(a)	4.70	2.80	3.20	4.50	3.00	1.90	2.40	2.50	2.50	(a)
17	(a)	(a)	5.00	2.40	3.10	4.60	3.00	1.90	2.40	2.50	2.50	(a)
18	(a)	(a)	4.70	2.40	3.10	4.50	2.90	2.00	2.50	2.50	2.50	(a)
19	(a)	(a)	4.50	2.50	2.90	4.50	2.70	2.00	2.60	2.50	2.50	(a)
20	(a)	(a)	4.40	2.50	2.90	4.30	2.60	2.00	2.60	2.50	2.50	(a)
21	(a)	(a)	4.30	2.60	3.00	4.20	2.50	1.90	2.60	2.50	2.50	(a)
22	(a)	(a)	4.00	2.50	4.10	4.00	2.50	1.90	2.60	2.50	(a)	(a)
23	(a)	(a)	3.90	2.50	4.30	4.00	2.40	1.90	2.60	2.50	(a)	(a)
24	(a)	(a)	3.80	2.70	4.70	4.00	2.40	1.80	2.60	2.50	(a)	(a)
25	(a)	(a)	4.30	3.00	4.60	4.00	2.40	1.80	2.60	2.50	(a)	(a)
26	(a)	(a)	3.90	3.10	4.50	4.00	2.50	1.70	2.60	2.50	(a)	(a)
27	(a)	(a)	3.90	3.30	4.40	3.80	2.40	1.70	2.60	2.50	2.50	(a)
28	(a)	(a)	3.80	3.25	4.20	3.70	2.40	1.70	2.50	2.50	2.50	(a)
29	(a)	.....	3.60	3.25	4.50	3.60	2.60	1.70	2.50	2.50	2.50	(a)
30	(a)	.....	3.40	3.10	4.40	3.60	2.50	1.70	2.50	2.50	2.60	(a)
31	(a)	.....	3.40	.....	4.30	.....	2.40	1.60	.....	2.50	.....	(a)

[a] Frozen.

WEST GALLATIN RIVER NEAR SALESVILLE, MONT.

This station, which was established in July, 1895, is located at the highway bridge crossing the stream about 5 miles south of Salesville. It is described in Water-Supply Paper No. 49, page 260. Results of measurements for 1900 will be found in the Twenty-second Annual

Report, Part IV, page 280. The gage was verified June 5, 1901, by J. S. Baker. During 1901 the following measurements were made under the direction of Samuel Fortier:

List of discharge measurements of West Gallatin River near Salesville, Mont.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1901.	*Feet.*	*Sec.-ft.*	1901.	*Feet.*	*Sec.-ft.*
April 20	3.37	556	June 5	5.20	2,623
Do	3.68	687	Do	5.20	2,618
Do	3.71	707	September 5	3.08	513

Daily gage height, in feet, of West Gallatin River near Salesville, Mont., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.80	2.80	2.80	2.90	4.25	6.10	4.40	3.30	2.90	3.00	2.90	2.80
2	2.90	2.80	2.80	2.80	4.50	6.00	4.20	3.50	3.00	3.00	2.90	2.80
3	2.90	2.80	2.80	2.80	5.15	5.70	4.20	3.50	3.00	3.00	2.90	2.80
4	3.00	2.80	2.85	2.80	4.85	5.40	4.20	3.40	2.90	3.00	2.90	2.80
5	3.10	2.80	2.70	2.80	4.65	5.30	4.20	3.30	3.00	3.00	2.90	2.80
6	3.05	2.85	2.73	2.90	4.55	5.15	4.10	3.20	3.00	3.00	2.90	2.80
7	3.15	2.83	2.80	2.90	4.50	5.05	4.10	3.20	3.00	3.00	2.90	2.80
8	3.20	2.80	2.70	2.90	4.75	5.30	4.10	3.20	3.00	3.00	2.90	2.80
9	3.30	2.80	2.70	2.80	4.75	5.30	4.00	3.20	3.00	3.00	2.90	2.80
10	3.10	2.80	2.80	2.90	4.90	4.80	4.00	3.20	3.00	3.00	2.90	2.80
11	3.10	2.80	2.70	2.90	4.95	4.70	4.00	3.20	3.00	3.00	2.90	2.80
12	3.10	3.00	2.70	2.90	5.15	4.60	4.00	3.20	3.00	3.00	2.90	2.80
13	3.10	3.00	2.70	2.90	5.50	4.55	3.90	3.20	3.00	3.00	2.90	2.80
14	3.10	3.00	2.70	2.90	5.55	4.55	3.90	3.15	3.00	3.00	2.90	2.85
15	3.20	3.00	2.70	2.93	6.25	4.60	3.80	3.00	3.00	3.00	2.90	2.90
16	3.20	3.00	2.70	2.90	6.55	4.50	3.70	3.00	3.00	3.00	2.90	2.90
17	3.10	2.80	2.70	2.90	7.05	4.55	3.70	3.10	3.00	2.90	2.90	2.80
18	3.15	2.80	2.73	2.90	7.55	4.50	3.60	3.10	3.00	2.90	2.90	2.80
19	3.15	2.80	2.73	3.00	7.10	4.55	3.60	3.10	3.00	2.90	2.90	2.80
20	3.10	2.80	2.80	3.45	7.10	4.65	3.40	3.20	3.00	2.90	2.80	2.80
21	3.43	2.80	2.80	3.58	6.50	4.70	3.40	3.20	3.00	2.90	2.70	2.80
22	3.20	2.80	2.80	3.60	6.00	5.00	3.40	3.10	3.00	2.90	2.70	2.80
23	3.00	2.80	2.80	3.60	5.60	5.00	3.40	3.10	3.00	2.90	2.70	2.80
24	2.90	2.90	2.85	3.50	5.70	5.00	3.40	3.10	3.00	2.90	2.70	2.80
25	2.90	2.90	2.89	3.60	5.85	5.00	3.40	3.00	3.00	2.90	2.70	2.80
26	2.90	2.90	2.90	3.50	6.35	4.90	3.40	3.00	3.00	2.90	2.80	2.80
27	2.90	2.83	2.89	3.30	6.35	4.70	3.40	3.00	3.00	2.90	2.90	2.80
28	2.90	2.85	2.89	3.30	6.70	4.60	3.20	3.00	3.00	2.90	2.80	2.80
29	2.90	.....	2.89	3.45	6.25	4.50	3.20	3.00	3.00	2.90	2.80	2.80
30	2.80	.....	2.89	3.70	6.20	4.40	3.20	3.00	3.00	2.90	2.90	2.80
31	2.80	.....	2.80	.....	6.20	.....	3.10	3.00	.....	2.90	.....	2.80

GALLATIN RIVER AT LOGAN, MONT.

This station, which was established by F. H. Newell August 24, 1893, is located on the bridge of the Northern Pacific Railway at Logan. It is described in Water-Supply Paper No. 49, page 262. On account of the reconstruction of the Northern Pacific Railway bridge at which the station is located a temporary gage was established May 27, 1901, consisting of a 2 by 6 inch plank driven vertically into the bed of the river about 3 feet from the bank. The elevation was derived from soundings made in 1900. Bench marks were established on the upstream side of the east abutment as follows: The upper bench mark is halfway down on the beveled edge of the abutment, its elevation being 9.073 feet above datum. The lower bench mark

is a deep nail scratch in the concrete below the first and has an elevation of 8.343 feet above datum. On July 27 the datum of the gage was raised 1.23 feet. Results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 282. During 1901 the following measurements of discharge were made under the direction of Samuel Fortier:

List of discharge measurements of Gallatin River at Logan, Mont.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1901.	*Feet.*	*Sec.-ft.*	1901.	*Feet.*	*Sec.-ft.*
April 15		733	June 26	—1.43	172
Do		735	September 3	—1.09	264
May 27	4.65	4,588	October 20	1.02	547

Daily gage height, in feet, of Gallatin River at Logan, Mont., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	(a)				2.40	4.50	1.50	−1.43	−1.13	−0.53	1.00	1.10
2	(a)	1.00	1.70		2.40	4.30	1.30	−1.43	−1.13	−.53	1.00	1.10
3	(a)				2.40	4.20	1.30	−1.43	−1.03	−.53	1.00	1.10
4	(a)				2.40	4.20	1.20	−1.43	−1.03	−.53	1.00	1.10
5	(a)				2.70	3.80	1.20	−1.43	−1.03	−.53	1.00	1.10
6				1.00	2.70	3.75	1.10	1.43	1.03	.53	1.00	1.10
7					2.75	3.40	1.25	−1.43	−.93	−.53	1.00	1.10
8					2.60	3.40	1.10	−1.43	−.93	.53	1.00	(a)
9		(a)	1.00		2.55	3.30	.90	1.43	.93	−.53	1.00	(a)
10		(a)			2.40	3.20	.90	−1.43	−.83	.53	1.00	(a)
11		(a)			2.40	3.20	.80	−1.43	.83	.53	1.00	(a)
12		(a)			2.60	3.20	.70	−1.43	−.83	−.53	1.00	(a)
13		(a)		1.00	2.75	3.10	.60	−1.43	−.83	.53	1.00	(a)
14		(a)		1.10	2.90	2.90	.60	−1.43	.83	.53	1.00	(a)
15		(a)		1.10	3.15	2.90	.60	1.43	.73	−.53	1.00	(a)
16		(a)	1.00	1.10	3.20	2.80	.60	1.43	−.73	−.53	1.00	(a)
17				1.10	3.20	2.70	.60	−1.43	.73	.53	1.10	(a)
18				1.10	3.20	2.60	.60	1.33	.73	.53	1.10	(a)
19	(a)			1.10	3.10	2.60	.60	−1.33	.73	.53	1.10	(a)
20				1.10	3.25	2.50	.60	−1.33	.73	1.00	1.10	(a)
21				1.10	3.45	2.30	.60	1.33	.73	1.00	1.10	(a)
22				1.10	3.20	2.10	.60	1.33	.63	1.00	1.10	(a)
23		1.00	1.30	1.10	3.10	2.10	.60	1.33	.63	1.00	1.10	(a)
24				1.20	2.85	2.10	.60	1.33	.53	1.00	1.10	(a)
25				1.20	2.60	2.00	.60	1.33	.53	1.00	1.10	(a)
26	(a)			1.20	4.55	2.00	−1.43	1.33	.53	1.00	1.10	(a)
27				1.20	4.60	1.90	−1.43	−1.23	−.53	1.00	1.10	(a)
28				1.20	4.90	1.90	1.43	−1.23	−.53	1.00	1.10	(a)
29				2.05	5.00	1.80	1.43	1.23	.53	1.00	1.10	(a)
30			1.00	2.30	5.15	1.50	1.43	1.23	−.53	1.00	1.10	(a)
31					4.95		−1.43	−1.23		1.00		(a)

[a] Frozen.

MADISON RIVER NEAR REDBLUFF, MONT.

This station, which was established May 2, 1897, is located 4 miles below the Redbluff iron county bridge over the river and 1½ miles below the mouth of Cherry Creek. It is described in Water-Supply Paper No. 49, page 263. Results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 284. On June 6, 1901, a bench mark was established by J. S. Baker on a large bowlder 20 feet south of the gage rod and 8 feet east of the river

bank. It is marked with black paint, and has an elevation of 6.856 feet above the datum of the gage.

Cherry Creek flows into Madison River between the gage and the point where the river is measured, and its discharge should, therefore, be added to that of the river in order to obtain the total discharge at the gage. During 1901 the following measurements of discharge of Madison River and Cherry Creek were made under the direction of Samuel Fortier:

List of discharge measurements of Madison River and Cherry Creek near Redbluff, Mont.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1901.	*Feet.*	*Sec.-ft.*	1901.	*Feet.*	*Sec.-ft.*
April 20	1.45	1,481	April 22	1.45	[a] 83
April 21	1.45	1,490	June 6	2.20	3,595
Do	1.45	1,441	Do	2.20	[a] 95
April 22	1.45	[a] 92	September 6	1.31	1,341

[a] Cherry Creek.

Daily gage height, in feet, of Madison River near Redbluff, Mont., for 1901.

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1		1.60	1.95	2.80	1.80	1.55	1.40	1.40	1.40	1.40
2		1.60	2.00	2.75	1.80	1.50	1.40	1.40	1.40	1.40
3		1.60	2.35	2.70	1.80	1.50	1.40	1.40	1.40	1.40
4		1.60	2.53	2.50	1.80	1.45	1.40	1.40	1.40	1.40
5		1.60	2.48	2.50	1.80	1.45	1.40	1.40	1.40	1.40
6		1.60	2.25	2.45	1.80	1.60	1.40	1.40	1.40	1.40
7		1.60	2.00	2.30	1.80	1.50	1.40	1.40	1.40	1.40
8		1.60	2.00	2.10	1.80	1.40	1.40	1.40	1.40	1.40
9		1.60	2.00	2.05	1.80	1.55	1.40	1.40	1.40	1.40
10		1.60	2.00	2.00	1.80	1.55	1.40	1.40	1.40	1.40
11		1.60	2.00	2.00	1.65	1.45	1.40	1.40	1.40	1.40
12		1.60	2.15	2.00	1.60	1.45	1.40	1.40	1.40	1.40
13		1.60	2.40	2.10	1.60	1.45	1.40	1.40	1.40	1.40
14		1.60	2.60	2.10	1.60	1.45	1.40	1.40	1.40	1.40
15		1.60	2.85	2.00	1.60	1.45	1.40	1.40	1.40	([a])
16		1.60	3.00	2.00	1.60	1.45	1.40	1.40	1.40	([a])
17		1.60	3.05	2.00	1.60	1.45	1.40	1.40	1.40	([a])
18		1.60	3.60	2.00	1.60	1.40	1.40	1.40	1.40	([a])
19		1.60	3.65	2.00	1.60	1.40	1.40	1.40	1.40	([a])
20		1.60	3.60	2.00	1.60	1.40	1.40	1.40	1.40	([a])
21		1.60	3.35	2.00	1.60	1.40	1.40	1.40	1.40	([a])
22		1.60	3.30	2.10	1.60	1.40	1.40	1.40	1.40	([a])
23		1.60	3.05	2.00	1.60	1.40	1.40	1.40	1.40	([a])
24		1.65	2.95	2.00	1.60	1.40	1.40	1.40	1.50	([a])
25		1.70	2.75	1.95	1.50	1.40	1.40	1.40	1.50	([a])
26		1.70	2.70	1.90	1.50	1.40	1.40	1.40	1.50	([a])
27		1.70	2.85	1.90	1.50	1.40	1.40	1.40	1.50	([a])
28		1.70	3.05	1.90	1.55	1.40	1.40	1.40	1.50	([a])
29		1.70	3.10	1.90	1.50	1.40	1.40	1.40	1.50	([a])
30		1.73	3.00	1.80	1.50	1.40	1.40	1.40	1.50	([a])
31	1.60		2.80		1.50	1.40		1.40		([a])

[a] Ice.

JEFFERSON RIVER AT SAPPINGTON, MONT.

This station, which was established by A. P. Davis in 1894, is located on the bridge of the Northern Pacific Railway crossing the river at Sappington. It is described in Water-Supply Paper No. 49, page 264. Results of measurements for 1899 and 1900 will be found in the Twenty-second Annual Report, Part IV, page 285. During

1901 the following measurements were made under the direction of Samuel Fortier:

List of discharge measurements of Jefferson River at Sappington, Mont.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1901.	*Feet.*	*Sec. feet.*	1901.	*Feet.*	*Sec. feet.*
April 10	2.29	1,092	May 23	5.61	7,677
Do	2.30	1,106	September 2	1.17	493
May 23	5.64	7,615	September 11	1.60	724

Daily gage height, in feet, of Jefferson River at Sappington, Mont., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	(a)	(a)	(a)	2.30	4.85	5.60	3.05	1.50	1.30	1.80	2.00	2.10
2	(a)	(a)	(a)	2.30	4.90	5.25	3.00	1.50	1.30	1.80	2.00	2.10
3	(a)	(a)	(a)	2.30	5.00	4.95	2.90	1.50	1.20	1.80	2.00	2.10
4	(a)	(a)	(a)	2.30	5.10	4.65	2.75	1.50	1.30	1.80	2.00	2.10
5	(a)	(a)	(a)	2.30	5.10	4.50	2.70	1.50	1.40	1.80	2.05	2.10
6	(a)	(a)	(a)	2.30	5.00	4.35	2.70	1.50	1.40	1.80	2.05	2.10
7	(a)	(a)	(a)	2.30	5.00	4.10	2.60	1.50	1.40	1.80	2.05	2.10
8	(a)	(a)	2.60	2.30	4.90	3.90	2.60	1.50	1.50	1.80	2.10	2.10
9	(a)	(a)	2.60	2.40	4.80	3.75	2.50	1.50	1.55	1.80	2.10	2.10
10	(a)	(a)	2.60	2.40	4.80	3.70	2.50	1.50	1.60	1.80	2.10	2.10
11	(a)	(a)	2.60	2.40	4.80	3.55	2.40	1.50	1.60	1.80	2.10	2.10
12	(a)	(a)	2.60	2.50	4.85	3.55	2.30	1.40	1.60	1.80	2.10	2.10
13	(a)	(a)	2.60	2.50	4.90	3.70	2.20	1.40	1.60	1.80	2.10	2.20
14	(a)	(a)	2.50	2.50	5.05	3.70	2.20	1.40	1.60	1.80	2.10	2.20
15	(a)	(a)	2.50	2.50	5.20	3.70	2.10	1.40	1.58	1.80	2.10	2.20
16	(a)	(a)	2.50	2.60	5.45	3.70	2.00	1.40	1.55	1.80	2.10	2.20
17	(a)	(a)	2.50	2.60	5.65	3.60	2.00	1.40	1.55	1.80	2.10	2.30
18	(a)	(a)	2.50	2.70	6.00	3.50	1.90	1.40	1.55	1.80	2.10	(a)
19	(a)	(a)	2.40	2.80	6.25	3.50	1.90	1.40	1.60	1.80	2.10	(a)
20	(a)	(a)	2.40	2.90	6.30	3.35	1.80	1.40	1.60	1.80	2.10	(a)
21	(a)	(a)	2.40	3.10	6.10	3.20	1.80	1.40	1.60	1.85	2.10	3.10
22	(a)	(a)	2.40	3.20	6.00	3.05	1.70	1.40	1.65	1.85	2.10	.....
23	(a)	(a)	2.40	3.45	5.80	3.00	1.70	1.40	1.70	1.85	2.10	.....
24	(a)	(a)	2.40	3.85	5.50	3.20	1.65	1.40	1.73	1.90	2.10	.....
25	(a)	(a)	2.40	4.00	5.20	3.30	1.60	1.40	1.75	1.90	2.10	.....
26	(a)	(a)	2.40	4.10	5.15	3.50	1.60	1.40	1.75	1.90	2.20	.....
27	(a)	(a)	2.40	4.10	5.20	3.55	1.60	1.40	1.80	1.90	2.20	.....
28	(a)	(a)	2.30	4.05	5.25	3.60	1.60	1.40	1.80	1.90	2.20	3.30
29	(a)	.....	2.30	4.35	5.65	3.50	1.60	1.40	1.80	1.95	2.20	.....
30	(a)	.....	2.30	4.70	5.70	3.35	1.60	1.40	1.80	1.95	2.10	.....
31	(a)	.....	2.30	.....	5.65	.....	1.50	1.40	.....	1.95	.....	.....

[a] Frozen.

MISSOURI RIVER NEAR TOWNSEND, MONT.

Observations of gage heights are maintained at this place by the Missouri River Commission, and the results are furnished to the Geological Survey by the Corps of Engineers, United States Army. The heights given are the means of two daily readings expressed in feet above the St. Louis directrix, which is 412.73 feet above the mean Gulf level. The figures 3,300 have been omitted from the record, so that it is necessary to add that amount to the daily observations to obtain the elevation of the water surface above the St. Louis datum. A description of this station will be found in Water-Supply Paper No. 49, page 265. Results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 286. During 1901

the following discharge measurements were made under the direction of Samuel Fortier:

April 11: Gage height, 88.75 feet; discharge, 2,880 second-feet.
April 23: Gage height, 89.90 feet; discharge, 6,631 second-feet.
April 23: Gage height, 89.90 feet; discharge, 6,638 second-feet.
May 29: Gage height, 92.28 feet; discharge, 17,445 second-feet.
September 2: Gage height, 88.20 feet; discharge, 1,383 second-feet.

Daily gage height, in feet, of Missouri River near Townsend, Mont., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	87.9	90.3	90.8	88.8	90.1	92.6	89.6	88.3	88.1	88.5	88.7	88.8
2	88.9	90.3	90.9	88.8	90.3	92.2	89.5	88.3	88.1	88.6	88.7	88.8
3	89.1	90.2	90.9	88.7	90.6	91.9	89.4	88.3	88.0	88.7	88.7	88.8
4	89.3	90.3	93.0	88.7	90.9	91.6	89.3	88.3	88.1	88.7	88.7	88.8
5	89.4	90.4	93.1	88.7	91.1	91.4	89.2	88.3	88.1	88.8	88.7	88.8
6	89.4	90.4	93.1	88.7	91.2	91.2	89.1	88.3	88.2	88.8	88.7	88.8
7	89.6	90.4	89.2	88.7	91.2	90.9	89.0	88.2	88.2	88.8	88.8	88.8
8	89.8	90.4	89.2	88.7	91.1	90.8	89.0	88.2	88.2	88.8	88.8	88.8
9	90.1	90.4	89.2	88.8	90.9	90.7	89.0	88.2	88.3	88.8	88.8	88.8
10	90.2	90.5	89.2	88.8	90.9	90.6	88.9	88.2	88.3	88.7	88.8	88.8
11	90.2	90.5	89.2	88.9	90.9	90.5	88.9	88.2	88.3	88.7	88.8	88.8
12	90.2	90.5	89.1	89.0	90.9	90.5	88.9	88.2	88.3	88.7	88.8	88.8
13	90.1	90.6	88.9	89.0	91.1	90.4	88.8	88.2	88.3	88.7	88.8	91.2
14	90.1	90.7	88.8	89.1	91.2	90.4	88.7	88.2	88.3	88.7	88.8	91.2
15	90.1	90.7	88.8	89.2	91.5	90.3	88.7	88.1	88.3	88.6	88.8	91.2
16	90.1	90.7	88.8	89.3	92.1	90.4	88.7	88.1	88.3	88.6	88.8	91.6
17	90.1	90.7	88.8	89.3	92.4	90.2	88.6	88.1	88.3	88.6	88.8	92.3
18	90.1	90.7	88.8	89.3	92.6	90.1	88.6	88.1	88.3	88.6	88.8	92.5
19	90.1	90.7	88.8	89.3	92.9	89.9	88.6	88.1	88.3	88.6	88.8	92.2
20	90.1	90.7	88.8	.....	93.0	89.9	88.6	88.1	88.3	88.6	88.8	91.7
21	90.1	90.7	88.8	89.5	93.0	89.9	88.6	88.1	88.4	88.6	88.8	91.5
22	90.1	90.7	88.8	89.6	92.6	89.9	88.5	88.1	88.4	88.6	88.8	91.4
23	90.0	90.7	88.8	89.9	92.4	90.0	88.4	88.1	88.4	88.6	88.8	91.4
24	90.0	90.7	88.8	89.8	92.3	89.9	88.4	88.1	88.4	88.6	88.8	91.4
25	90.0	90.7	88.8	89.7	92.2	89.8	88.4	88.1	88.4	88.6	88.8	91.4
26	90.0	90.8	88.8	89.7	92.1	89.7	88.3	88.1	88.4	88.6	88.8	91.4
27	90.0	90.8	88.8	89.7	92.2	89.6	88.3	88.1	88.4	88.6	88.8	91.4
28	90.0	90.8	88.8	89.7	92.5	89.6	88.2	88.1	88.4	88.6	88.8	91.4
29	90.0	.....	88.8	89.7	92.5	89.6	88.2	88.1	88.4	88.6	88.8	91.4
30	90.2	.....	88.8	89.9	92.7	89.6	88.2	88.1	88.4	88.6	88.8	91.4
31	90.3	.....	88.8	.....	92.7	.....	88.2	88.1	.....	88.7	.....	91.4

CROW CREEK NEAR RADERSBURG, MONT.

A gaging station was established April 13, 1901, by J. S. Baker, on Crow Creek, a tributary of Missouri River, at a point about 6 miles above Radersburg and about one-fourth of a mile above the head of the Placer mine ditch. The equipment consists of a $\frac{3}{8}$-inch cable with car, and a tag wire marked at 5-foot intervals. The gage is located about 50 feet above the cable, and consists of a sash weight attached to a $\frac{3}{32}$-inch wire cable passing over a pulley and along a graduated arm which carries graduations from 0 to 8 feet. The index is a knot in the cable; the channel is straight; the bottom is of coarse gravel and has considerable fall. On May 29, 1901, a bench mark was established on a bowlder 16 feet north of the rear post which supports the gage. The elevation of the highest point of the bowlder is 6.81 feet above the zero of the gage. The following measurements were made by J. S. Baker during 1901:

April 13: Gage height, 1.85 feet; discharge, 15 second-feet.
May 29: Gage height, 3.20 feet; discharge, 199 second-feet.
May 29: Gage height, 3.20 feet; discharge, 190 second-feet.

Daily gage height of Crow Creek near Radersburg, Mont., for 1901.

Day.	Apr.	May.	June.	Day.	Apr.	May.	June.	Day.	Apr.	May.	June.
1		2.70	3.35	12		3.20	2.55	22	2.10	3.40	2.35
2		4.50	3.10	13				23	2.20	3.30	2.30
3		5.20	2.95	14	1.95	3.40	2.40	24	2.20	3.35	2.35
4		4.25	2.85	15	1.90	3.50	2.40	25	2.25		2.40
5		3.40	2.90	16	1.90	3.40	2.40	26	2.30	3.35	2.50
6		3.30	2.90	17	1.85	3.55	2.35	27	2.25	3.30	2.50
7		3.50		18	1.90	3.60	2.30	28	2.10	3.35	2.40
8		3.40	2.90	19	1.90	3.60	2.25	29	2.20	3.30	2.45
9		3.50	2.80	20	2.00	3.40	2.20	30	2.55	3.40	
10		3.30	2.65	21	2.10	3.50	2.30	31		3.30	
11		3.10	2.60								

YELLOWSTONE RIVER NEAR LIVINGSTON, MONT.

This station, which was established May 2, 1897, is located at the highway bridge over the Yellowstone, 5 miles south of Livingston. It is described in Water-Supply Paper No. 49, page 268. Results of measurements for 1899 and 1900 will be found in the Twenty-second Annual Report, Part IV, page 289. During 1901 the following measurements of discharge were made under the direction of Samuel Fortier:

List of discharge measurements of Yellowstone River near Livingston, Mont.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1901.	*Feet.*	*Sec.-ft.*	1901.	*Feet.*	*Sec.-ft.*
April 18	−0.90	1,254	June 4	4.13	13,265
Do	.90	1,225	September 10	−.01	2,302
Do	.90	1,247	November 17	.88	1,477
May 21	5.40	21,874	Do	−.88	1,437

Daily gage height, in feet, of Yellowstone River near Livingston, Mont., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	[a]		−1.00	1.00	0.45	4.20	2.90	0.90	0.10	0.25	−0.55	0.90
2			.90	1.00	1.45	4.20	2.80	1.10	.05	.25	−.55	
3			−1.15	1.00	1.90	4.10	2.95	1.45	.10	−.25	.60	
4		1.45	1.40	−.95	2.25	4.00	2.80	1.10	.20	.25	.60	
5	[a]		−1.30	−.95	1.85	3.90	2.75	1.00	.20	−.25	−.60	
6			1.10	.95	1.75	3.70	2.70	.90	.15	.25	.60	1.10
7			−1.00	−.90	1.90	3.75	2.50	.80	.10	−.25	.60	
8			1.00	−.90	2.20	3.70	2.45	.80	.05	−.30	−.65	
9			−1.00	−.95	2.30	3.50	2.40	.80	.05	−.30	−.65	1.30
10	[a]	−1.45	−1.00	−.90	2.50	3.50	2.30	.80	.00	−.30	.70	
11		1.45	−1.05	.90	2.80	3.40	2.30	.70	−.10	−.25	−.70	
12			−1.10	−.85	3.20	3.40	2.30	.60	−.10	−.25	−.70	
13	[a]		−1.00	.75		3.30	2.20	.55	−.10	−.30	−.70	
14	1.10		−1.00	.75	3.50	3.20	2.10	.50	−.10	−.30	−.75	
15			−1.00	.85	3.80	3.10	2.00	.50	−.10	−.30	−.75	
16			−1.00	.80	3.90	3.10	1.95	.50	−.15	−.35	−.80	
17			1.00	.90	4.30	3.00	1.85	.40	−.20	−.35	−.80	
18		1.45	.95	−.85	5.00	3.30	1.70	.40	−.20	−.40	−.85	
19			−.95	.85	6.00	3.80	1.65	.35	−.20	−.40	−.85	
20			−.95	−.80	6.10	3.60	1.55	.45	−.25	−.45	−.90	
21	1.35		−1.00	−.70	5.50	3.70	1.50	1.00	−.25	−.45	.90	1.10
22			.90	−.60	5.10	3.60	1.40	.70	−.25	−.45	.90	1.10
23			−.90	−.50	4.10	3.60	1.35	.45	−.25	−.45	.90	
24			.90	.35	4.00	3.80	1.35	.40	−.15	−.50		−1.10
25		−1.30	.90	−.25	4.00	3.50	1.35	.30	.00	−.50		1.15
26			−.85	−.25	4.30	3.60	1.30	.25	.00	.50		1.10
27			−.90	−.30	4.80	3.20	1.25	.20	−.10	−.55		
28	1.45		−.95	−.50	5.30	3.20	1.20	.20	−.15	−.55		−1.40
29			−.95	−.40	5.20	3.15	1.10	.20	−.15	−.55		−1.50
30			−1.00	−.10	5.10	3.10	1.05	.15	−.20	−.55		1.50
31			−1.00		4.60		.95	.10		−.55		

[a] Ice.

MISCELLANEOUS DISCHARGE MEASUREMENTS IN MISSOURI RIVER BASIN IN MONTANA.

Date.	Stream.	Locality.	Hydrographer.	Discharge.
1901.				*Sec.-ft.*
Aug. 7	South Fork of Milk River	Murphy's ranch	G. H. Matthes	35
Do.	North Fork of Milk River	McLeod trail ford	do	27
Oct. 24	Marias River	Near Shelby	C. C. Babb	296
Apr. 17	Bozeman Creek	Bozeman	J. S. Baker	21

BIGHORN RIVER NEAR THERMOPOLIS, WYO.

This station, which was established by A. J. Parshall on May 28, 1900, is located about a half mile west of Thermopolis at the ferry crossing the river. At the lowest water mark of 1901 the gage was changed; a gage was painted upon one of the lower piers of the new State bridge over the river, 400 or 500 feet upstream from the former station. The relative heights on rod remained as before, the same bench mark being used.

Results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 291. The station is described in Water-Supply Paper No. 49, page 269. During 1901 one discharge measurement was made by A. J. Parshall, but was considered by him unsatisfactory.

Daily gage height, in feet, of Bighorn River near Thermopolis, Wyo., for 1901.

Day.	May.	June.	July.	Aug.	Sept.	Day.	May.	June.	July.	Aug.	Sept.
1	1.55	6.85	3.05	2.00	1.60	17	5.60	2.85	3.05	1.65	1.00
2	1.67	6.60	2.95	1.90	1.80	18	6.10	2.90	3.15	1.60	1.00
3	2.00	6.20	3.10	2.00	1.65	19	6.50	3.15	3.25	1.35	1.00
4	2.70	5.80	3.00	2.15	1.60	20	7.30	3.20	3.20	1.25	1.00
5	2.90	5.45	3.15	1.95	1.45	21	7.95	3.45	2.75	1.10	.90
6	3.10	5.25	3.20	1.75	1.30	22	7.85	3.70	2.65	1.35	.90
7	2.95	5.00	3.10	1.65	1.30	23	7.30	3.95	2.60	1.45	1.00
8	3.00	4.55	2.95	1.80	1.20	24	6.65	4.15	2.45	1.40	1.20
9	2.85	4.30	2.95	1.65	1.20	25	6.05	4.15	2.40	1.30	1.20
10	3.15	4.45	3.05	1.55	1.20	26	5.65	4.00	2.50	1.20	1.10
11	3.35	4.15	3.15	1.65	1.10	27	5.85	3.85	2.60	1.20	1.00
12	3.45	3.95	3.25	1.60	1.10	28	6.25	3.60	2.50	1.20	1.00
13	3.45	3.70	3.20	1.50	1.00	29	6.70	3.35	2.40	1.20	.90
14	3.70	3.40	3.10	1.45	1.00	30	7.30	3.20	2.25	1.20	.90
15	4.15	3.05	2.95	1.35	1.00	31	7.25		2.15	1.20	
16	4.40	2.85	2.95	1.55	1.00						

Miscellaneous discharge measurements of Shell Creek and tributaries, Wyoming.

Date.	Stream.	Locality.	Discharge.
1901.			*Sec.-ft.*
July 3	Shell Creek	6 miles above Shell, Wyo	451
July 8	Horse Creek		3
July 16	Beaver Creek		4
July 21	Shell Creek	7 miles above Shell, Wyo	76
July —	Trapper Creek		40

BIG SIOUX RIVER NEAR WATERTOWN, S. DAK.

The gaging station was established by O. V. P. Stout September 15, 1900. It is described in Water-Supply Paper No. 49, page 270. One discharge measurement was made during 1901 by A. B. Crane, on October 19, when the gage read 1.12 feet, and the discharge was found to be 8 second-feet.

Daily gage height, in feet, of Big Sioux River near Watertown, S. Dak., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.15	1.60	1.70		2.15				0.75	1.30	1.00	0.9
2				2.65		1.10	1.25	0.85				
3		1.60	1.70	4.70	2.10				.75		1.00	.88
4	1.15					1.05		.85		1.20		
5		1.60	2.30	3.70	1.90		1.20				.95	
6	1.15		3.85					.85	.75	1.20		.88
7				2.80	1.85	1.15	1.20					
8	1.15	1.65	3.00						.85	1.24	.95	
9				4.85		1.20	1.15	1.00				
10		1.65	2.45		1.90				.85		.93	
11	1.15					1.20		.95		1.20		
12		1.65	2.40	2.80	1.80		1.10				.93	
13	1.20							.90	1.35	1.20		
14				1.90	1.60	1.20	1.05					
15	1.50	1.65	2.40						1.35	1.18	.90	
16				1.65		1.25	1.02	.80				
17		1.65	2.40		1.40				1.30		.90	
18	1.50		2.80			1.35		.80		1.13		
19		1.65	4.40	1.40	1.40		.95				.90	
20	1.50		4.20					.75	1.25	1.10		
21				1.35	1.30	1.80	.95					
22	1.50	1.65	3.45						1.15	1.10	.90	
23				1.25		1.65	.90	.75				
24		1.65	2.40		1.25				1.05		.90	
25	1.55					1.50		.90		1.05		
26		1.65	2.40	1.20	1.25		.85				.90	
27	1.55							.90	1.04	1.05		
28				1.20	1.20	1.35	.85					
29	1.55		2.40						1.25	1.05	.90	
30				1.90		1.30	1.15	.80				
31			2.35		1.10							

BIG SIOUX RIVER NEAR SIOUX FALLS, S. DAK.

This gaging station, which was established by O. V. P. Stout, on July 21, 1900, is 2 miles west of Sioux Falls, and is described in Water-Supply Paper No. 49, page 271. During 1901 the following discharge measurements were made by O. V. P. Stout:

April 8: Gage height, 2.33 feet; discharge, 126 second-feet.
April 8: Gage height, 2.33 feet; discharge, 130 second-feet.
April 9: Gage height, 2.34 feet; discharge, 131 second-feet.
April 9: Gage height, 2.34 feet; discharge, 145 second-feet.
October 26: Gage height, 1.24 feet; discharge, 18 second-feet.

Daily gage height, in feet, of Big Sioux River near Sioux Falls, S. Dak., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1		[a]	[a]	1.10		2.10	2.40	1.10	.60	1.20	1.20	1.40
2	1.8	[a]		1.11		2.10	2.40	1.10	.60	1.20	1.30	1.50
3	[a]			1.11		2.10	2.30		.60	1.20	1.40	1.30
4	[a]			1.11		2.20	2.30		.70	1.20	1.40	1.20
5	[a]			1.11	2.30	2.20	2.40		.80	1.20	1.40	1.20
6				1.11	2.30	2.20	2.40		.80	1.20	1.40	1.20
7				1.10	2.30	2.20	1.80		.90	1.30	1.40	1.20
8				1.10	2.30	2.20	1.80		1.10	1.30	1.50	
9				1.10	2.20	2.30	1.70		1.10	1.30	1.50	
10				1.10	2.20	2.30	1.60		1.20	1.30	1.50	
11				1.11	2.20	2.30	1.60	1.00	1.20	1.30	1.50	
12				1.12	2.20	2.30	1.50	1.00	1.20	1.30	1.50	
13				1.12	2.20	2.50	1.40	1.00	1.20	1.30	1.50	
14	[a]			1.12	2.20	2.80	1.40	1.00	1.20	1.30	1.50	
15	[a]			1.12	2.20	2.80	1.30	.90	1.20	1.30	1.40	
16	[a]			1.12	2.30	2.80	1.20	.90	1.20	1.30	1.40	
17	[a]		1.90	1.14	2.20	2.80	1.20	.90	1.10	1.30	1.40	
18	[a]			1.14	2.20	2.70	1.20	1.00	1.10	1.20	1.40	
19	[a]			1.13	2.20	2.70	1.10	1.00	1.20	1.20	1.40	
20	[a]			1.13	2.20	2.70	1.10	1.00	1.20	1.20	1.40	
21					2.10	2.70	1.10	.90	1.20	1.20	1.40	
22					2.10	2.70	1.00	.90	1.20	1.20	1.40	
23					2.00	2.60	1.00	.90	1.20	1.20	1.40	
24					2.00	2.60	1.00	.80	1.20	1.10	1.40	
25					2.10	2.60	.90	.80	1.30	1.10	1.50	
26			1.90		2.10	2.50	.90	.70	1.20	1.20	1.50	
27	[a]				2.00	2.50	.80	.70	1.20	1.20	1.50	
28	[a]				2.20	2.50	.80	.60	1.20	1.20	1.30	
29	[a]		1.80		2.00	2.50	1.20	.60	1.20	1.20	1.50	
30	[a]		1.11		2.20	2.50	1.20	.70	1.20	1.20	1.40	
31	[a]				2.10		1.20	.60		1.20		

[a] Frozen.

NIOBRARA RIVER AT VALENTINE, NEBR.

This station was formerly located at the military bridge on the road between Valentine, Nebr., and Fort Niobrara. On June 26, 1901, it was reestablished at the Borman bridge, which is about 3 miles up stream from the military bridge. The gage is of the wire and weight type, gage heights being marked by staples on the bridge rail. The zero of the gage is 12 feet below the top of the bridge floor.

During 1901 the following discharge measurements were made by O. V. P. Stout and others:

May 12: Gage height, — feet; discharge, 628 second-feet.
June 26: Gage height, 1.46 feet; discharge, 724 second-feet.
August 1: Gage height, 1.45 feet; discharge, 951 second-feet.
November 14: Gage height, 1.54 feet; discharge, 818 second-feet.

Daily gage height, in feet, of Niobrara River at Valentine, Nebr., for 1901.

Day.	June.	July.	Aug.	Sept.	Oct.	Nov.	Day.	June.	July.	Aug.	Sept.	Oct.	Nov.
1		1.61	1.35	1.55	1.38	1.53	17		1.22	1.32	1.45	1.45	1.67
2		1.35	1.40	1.50	1.46	1.49	18		1.20	1.30	1.36	1.49	1.63
3		1.37	1.40	1.47	1.48	1.47	19		1.40	1.27	1.42	1.55	1.65
4		1.32	1.38	1.75	1.46	1.46	20		1.35	1.25	1.38	1.54	1.70
5		1.30	1.30	1.62	1.40	1.53	21		1.25	1.40	1.33	1.49	1.63
6		1.28	1.32	1.42	1.43	1.49	22		1.22	1.35	1.45	1.48	1.68
7		1.24	1.28	2.68	1.52	1.51	23		1.18	1.29	1.36	1.46	1.65
8		1.25	1.25	1.80	1.55	1.50	24		1.15	1.40	1.45	1.52	1.66
9		1.40	1.29	1.65	1.63	1.55	25		1.25	1.35	1.43	1.45	1.65
10		1.30	1.35	1.53	1.90	1.50	26		1.30	1.45	1.35	1.50	1.66
11		1.35	1.40	1.60	1.70	1.68	27	1.45	1.40	1.38	1.43	1.45	1.64
12		1.30	1.25	1.58	1.68	1.70	28	1.38	1.35	1.39	1.48	1.45	1.65
13		1.20	1.28	1.53	1.65	1.63	29	1.37	1.30	1.38	1.45	1.51	1.69
14		1.21	1.40	1.58	1.55	1.54	30	1.36	1.33	1.40	1.40	1.52	1.70
15		1.20	1.30	1.50	1.52	1.70	31		1.30	1.55		1.54	
16		1.18	1.35	1.52	1.53	1.68							

PLATTE RIVER DRAINAGE.

MEDICINE BOW RIVER AT MEDICINE BOW, WYO.

This stream rises in the Laramie Mountains in Carbon and Albany counties, southwestern Wyoming, and flows first in a southerly and then in a westerly direction, discharging into the North Platte. The river is of interest, as along nearly its entire course its waters are used for irrigation purposes. The station was established May 7, 1901, by A. J. Parshall, near Medicine Bow, Wyo., a station on the Union Pacific Railroad, and was abandoned with the close of the season of 1901, the purposes for which it had been established having been accomplished. Measurements were made from the county bridge, one-half mile north of Medicine Bow station, and the gage rod was at pump house, one-half mile east of railroad station. The bench mark was a nail driven in timber 5 feet south of rod on level, with 4.25 foot-mark on rod.

The river at the point where the measurements were made is curved, the right bank is high and not liable to overflow, while the left bank is low and subject to overflow.

The following discharge measurements were made during 1901 by A. J. Parshall:

May 8: Gage height, 1.05 feet; discharge, 230.6 second-feet.
May 17: Gage height, 2 feet; discharge, 662.3 second-feet.
May 25: Gage height, 3 feet; discharge, 1,110 second-feet.
June 5: Gage height, 3.2 feet; discharge, 1,300 second-feet.
August 12: Gage height, —.5 feet; discharge, 6.5 second-feet.

Discharge measurements were made by him at Schulte ranch, as follows:

May 7: Gage height, 1.05 feet; discharge, 166 second-feet.
May 17: Gage height, 2 feet; discharge, 529 second-feet.
May 25: Gage height, 3 feet; discharge, 521 second-feet.
June 5: Gage height, 3.20 feet; discharge, 532 second-feet.

Daily gage height, in feet, of Medicine Bow River at Medicine Bow, Wyo., for 1901.

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Day.	May.	June.	July.	Aug.	Sept.	Oct.
1		4.15	1.08	.00	—.30	—.40	17	2.15	3.80	.00	—.30	—.30	
2		3.95	1.03	.00	—.40	—.40	18	2.25	2.85	.00	—.30	—.30	
3		3.45	1.00	.00	—.40	—.40	19	2.87	2.65	.00	—.30	—.30	
4		3.45	.90	—.40	—.40	—.40	20	3.20	2.75	.00	—.30	—.30	
5		2.95	.80	—.40	—.30	.40	21	3.87	2.30	.00	—.40	—.40	
6		3.00	.75	—.40	—.30		22	4.35	2.30	.00	—.50	—.50	
7		2.35	.65	—.40	—.30		23	4.80	2.30	.00	—.50	—.50	
8	1.02	2.10	.55	—.40	—.30		24	4.65	2.25	.00	—.50	—.50	
9	.85	2.35	.45	—.40	—.30		25	3.15	2.40	.00	—.30	—.30	
10	.90	2.75	.35	—.40	—.30		26	3.00	2.10	.70	—.30	—.30	
11	1.00	3.05	.25	—.30	—.30		27	3.00	1.95	.35	—.30	—.35	
12	1.20	3.05	.00	—.30	—.45		28	3.15	1.70	.20	—.30	—.35	
13	1.50	2.90	.00	—.30	—.30		29	3.15	1.45	.10	—.30	—.35	
14	1.75	2.65	.10	—.30	—.30		30	3.35	1.30	.05	—.30	—.35	
15	1.95	3.05	.00	—.30	—.30		31	3.55		.00	—.30	—	
16	2.00	3.80	.00	—.30	—.30								

NORTH PLATTE RIVER NEAR GUERNSEY, WYO.

This station was established by A. J. Parshall June 14, 1900, and is described in Water-Supply Paper No. 49, page 275. Results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 312.

During the years 1900 and 1901 the gage rod was located at the county bridge about one-half mile northwest of Guernsey. It was found that considerable inconvenience was caused by sand, which accumulated about the rod as the high water subsided and which settled to about the zero mark. With the opening of the season of 1902 a new rod was placed about 200 feet above the first location. It was fastened to one of the piers of the railroad bridge, and was placed 1 foot lower in the water.

Measurements are still made from the county bridge, which, while it does not furnish a perfect location for measurements, is the best yet found on the river in Wyoming.

The following discharge measurements were made by A. J. Parshall during 1901:

List of discharge measurements of North Platte River near Guernsey, Wyo.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1901.	*Feet.*	*Sec.-ft.*	1901.	*Feet.*	*Sec.-ft.*
March 17	−0.30	736	May 1	2.50	6,384
April 3	− .35	702	May 15	2.80	7,204
April 25	.70	1,929	May 30	3.80	9,644
May 1	2.75	7,106	August 29	−.60	420

Daily gage height, in feet, of North Platte River near Guernsey, Wyo., for 1901

Day.	Apr.	May.	June.	July.	Aug.	Sept.
1	−0.30	2.75	4.30	2.25	0.00	−0.60
2	− .30	2.60	4.30	1.85	.00	− .60
3	− .35	2.70	4.80	1.55	.00	− .60
4	− .35	2.70	4.90	1.35	.30	− .60
5	− .30	3.00	4.70	1.20	.30	− .60
6	− .30	3.10	4.50	1.10	.30	− .60
7	.25	3.00	4.20	1.10	.30	− .60
8	.20	2.80	3.90	1.00	.30	− .60
9	− .15	2.70	3.60	1.00	.30	.60
10	− .10	2.50	3.30	.80	.30	− .60
11	.00	2.40	3.20	.80	− .30	.60
12	.00	2.40	3.40	.60	.30	− .60
13	.00	2.45	3.20	.50	− .30	− .60
14	.00	2.65	3.30	.45	.30	.60
15	.20	2.90	3.65	.40	.30	− .70
16	.20	3.10	4.80	.30	.30	− .70
17	.20	3.30	4.65	.30	.30	− .70
18	.20	3.40	5.40	.20	.30	.70
19	.20	3.50	4.35	.10	− .30	− .80
20	.00	3.60	3.55	.00	.30	− .80
21	.00	3.80	3.35	.00	.30	− .80
22	.00	4.40	3.20	.00	.30	− .70
23	.10	4.60	3.00	.00	.30	− .70
24	.30	4.80	2.70	.00	.30	.80
25	.70	5.15	2.55	.00	.40	− .80
26	1.85	4.80	2.45	.00	.50	− .90
27	4.10	4.50	2.35	.00	.60	.90
28	2.90	4.10	2.25	.00	.60	1.00
29	2.70	3.90	2.20	.00	.60	1.00
30	2.70	3.80	2.45	.20	.60	1.00
31		4.10		.00	.60	

NORTH PLATTE RIVER AT MITCHELL, NEBR.

This station was established by O. V. P. Stout on June 3, 1901. It replaces the station at Gering, Nebr., which was discontinued, as the narrower channel at Mitchell seemed favorable to increased accuracy of gagings, and, being nearer the Wyoming line, it serves better as a State line gaging station.

The gage consists of a sash weight hung from a wire carrying an index reading on a horizontal rod nailed to the bridge rail. The zero of the gage is 8 feet below the bridge floor at the gage.

The observer is Earl Beers, clerk in a hardware store at Mitchell, about one-half mile from the bridge. The following discharge measurements were made by R. H. Willis and others during 1901:

List of discharge measurements of North Platte River at Mitchell, Nebr.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1901.	*Feet.*	*Sec.-ft.*	1901.	*Feet.*	*Sec.-ft.*
June 21	2.32	8,478	August 24	−0.72	351
June 3	2.67	10,521	September 3	− .77	227
July 2	1.27	1,114	September 11	− .62	422
July 11	.37	1,768	September 24	− .75	341
July 19	− .24	1,048	October 11	− .71	302
August 3	− .28	1,038	October 29	− .61	438
August 12	− .55	566	November 26	− .55	576

Daily gage height, in feet, of North Platte River at Mitchell, Nebr., for 1901.

Day.	June.	July.	Aug.	Sept.	Oct.	Nov.	Day.	June.	July.	Aug.	Sept.	Oct.	Nov.
1		1.40		−0.82	−0.77	−0.60	17	2.40	0.06	−0.65	−0.73	−0.60	
2		1.27		− .81	− .77	− .60	18	2.60	.05	− .66	− .75	− .60	
3		1.21	−0.28	− .77	− .77		19	2.50	.03	− .65	− .75	− .60	
4		1.09		− .80	− .76		20	2.40	.01	− .66	− .72	− .57	
5		1.01		− .60	− .76		21	2.32		− .65	− .75	− .60	
6		1.00		− .65	− .75		22	2.22		− .70	− .75	− .60	
7		.94		.63	− .75		23	1.90		− .70	− .76	− .60	
8		.82		.63	− .76		24	1.75		− .72	− .75	− .60	
9	2.50	.65		.66	− .77		25	1.60		− .75	.75	− .60	
10	2.30	.57		− .65	− .75		26	1.55		− .75	− .77	.60	−0.55
11	2.15	.48		.62	− .71		27	1.42		− .77	− .75	.60	
12	2.15	.31	− .55	.66	− .78		28	1.41		− .80	.78	− .60	
13	2.00	.22	− .60	.70	− .67		29	1.40		− .80	− .78	− .60	
14	2.00	.22	− .65	.72	− .60		30	1.40		− .72	− .76	− .60	
15	3.00	.11	− .65	.72	− .55		31			− .82		− .62	
16	2.30	.08	− .62	.73	− .60								

NORTH PLATTE RIVER AT NORTH PLATTE, NEBR.

This station, which was established in 1894, is on North Platte River, 3.5 miles above its junction with South Platte River. It is described in Water-Supply Paper No. 49, page 277. During 1901 the following discharge measurements were made by O. V. P. Stout and Frank Dobson:

July 17: Gage height, 1.80 feet; discharge, 9 second-feet.
December 27: River frozen; discharge, 1,536 second-feet.

Daily gage height, in feet, of North Platte River at North Platte, Nebr., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	2.10	2.70	3.15	2.60	2.30	3.35	2.70	1.10	1.95	1.60	2.00
2	2.10	2.60	3.40	2.60	2.90	3.25	2.60	1.10	1.95	1.60	2.00
3	2.20	2.50	3.15	2.60	3.05	3.20	2.60	1.00	1.85	1.60	2.00
4	2.90	2.45	3.20	2.40	3.00	3.20	2.60	.90	1.95	1.65	2.00
5	2.50	2.40	3.20	2.25	3.10	3.40	2.50	.80	2.00	1.70	2.00
6	2.50	2.50	2.70	2.30	3.10	3.50	2.50	.80	2.00	1.75	2.00
7	2.50	2.55	2.30	2.25	3.05	3.50	2.45	.75	2.00	1.95	1.95
8	2.50	2.60	2.50	2.10	3.00	3.60	2.40	.80	2.05	1.85	2.00
9	2.50	2.60	2.50	2.10	3.00	3.60	2.35	.95	2.00	1.80	2.00
10	2.50	2.60	2.40	2.30	3.00	3.60	2.25	.85	1.95	2.00	2.00
11	2.50	2.60	2.50	2.65	3.10	3.60	2.20	1.10	2.10	2.05	2.00
12	2.50	2.50	2.30	2.80	3.00	3.90	2.20	1.40	2.15	2.00	2.10
13	2.50	2.50	2.20	2.65	3.00	3.40	2.15	1.40	2.15	1.85	2.10
14	2.50	2.45	2.15	2.50	3.00	3.45	2.00	1.25	2.00	1.90	2.10
15	2.55	2.55	2.30	2.50	3.00	3.50	1.95	1.20	1.85	1.85	2.15
16	2.60	2.80	2.20	2.40	3.00	3.50	1.80	1.30	1.75	1.90	2.20
17	2.60	2.90	2.20	2.40	2.90	3.45	1.80	1.30	1.70	1.90	2.20
18	2.60	2.90	2.20	2.35	2.90	3.35	1.80	1.30	1.75	1.90	2.20
19	2.70	2.90	2.50	2.30	2.90	3.30	1.80	1.25	1.90	1.90	2.20
20	2.70	2.85	2.15	2.30	2.95	3.60	1.80	1.20	1.90	1.90	2.20
21	2.70	2.80	2.20	2.30	3.00	3.35	1.60	1.65	1.85	2.00	2.20
22	2.85	2.90	2.20	2.20	3.05	3.20	1.35	1.70	1.70	2.00	2.20
23	2.90	3.00	2.20	2.20	3.40	3.45	1.20	1.45	1.60	2.00	2.20
24	3.00	3.00	2.20	2.15	3.45	3.25	1.10	1.40	1.60	2.00	2.20
25	3.00	3.00	2.10	2.10	3.50	3.20	1.00	1.30	1.60	2.00	2.20
26	3.00	2.90	2.10	2.10	3.60	3.05	1.50	1.25	1.60	2.00	2.20
27	3.00	2.95	2.20	2.10	3.60	3.00	1.40	1.30	1.50	2.00	2.20
28	2.95	3.00	2.00	2.15	3.70	2.90	1.25	1.35	1.50	2.00	2.20
29	2.90	.....	2.00	2.30	3.65	2.80	.90	1.40	1.50	2.00	2.10
30	2.80	.....	2.20	2.30	3.50	2.70	.80	1.40	1.35	2.00	2.10
31	2.75	.....	3.20	.....	3.40	.....	1.15	1.70	.....	2.00	.....

SOUTH FORK OF SOUTH PLATTE RIVER AT CHEESMAN, COLO.

The following statement of the flow of the South Fork of South Platte River at Lake Cheesman was furnished through the courtesy of C. L. Harrison, chief engineer of the Denver Union Water Company, who has daily measurements made at that point.

Observations were commenced on July 31, 1899, and the record for that year is published in Water-Supply Paper No. 37, page 223.

Discharge in second-feet of South Fork of South Platte River at Cheesman, Colo., for 1901.

Month.	Maximum.	Minimum.	Average.	Month.	Maximum.	Minimum.	Average.
January	16	13	14	July	195	30	92
February	19	12	15	August	753	172	342
March	95	17	67	September	295	120	166
April	346	67	198	October	134	65	99
May	557	105	341	November	134	85	104
June	600	70	260	December	325	35	88

SOUTH PLATTE RIVER AT DENVER, COLO.

This station is located at the Fifteenth street bridge in the city of Denver, a short distance below the mouth of Cherry Creek, and is described in Water-Supply Paper No. 49, page 281. It was established July 15, 1895, and has been maintained continuously. Results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 319. During 1901 the inclined gage on the right bank of the river, a short distance below the bridge, was used, the observations having been made by S. M. Matlock and his successor, J. A. Banning, water commissioners of water district No. 2, in which Denver is located. During 1901 four gagings were made at this point as given below. The daily gage height, with corresponding discharge, was published in the Denver papers by the United States Weather Bureau.

April 30: Gage height, 6.70 feet; discharge, 830 second-feet.
May 11: Gage height, 5.67 feet; discharge, 270 second-feet.
June 28: Gage height, 5.50 feet; discharge, 192 second-feet.
August 7: Gage height, 6.30 feet; discharge, 676 second-feet.

Daily gage height, in feet, of South Platte River at Denver, Colo., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	5.50	5.30	5.40	5.50	6.60	6.85	5.70	5.60	5.85	5.25	4.20	5.20
2	5.50	5.30	5.40	5.50	6.50	6.80	5.70	5.60	6.00	5.40	4.80	5.30
3	5.50	5.30	5.40	5.50	6.55	7.00	5.95	5.60	5.80	5.20	4.80	5.00
4	5.50	5.40	5.40	5.50	6.50	6.90	6.25	5.65	6.00	5.20	4.80	5.25
5	5.40	5.40	5.40	5.50	6.40	6.80	6.20	5.60	5.65	5.00	4.50	5.35
6	5.40	5.40	5.50	5.50	6.40	6.60	6.10	5.60	5.60	4.80	4.50	5.40
7	5.50	5.40	5.50	5.50	6.40	6.00	5.90	6.32	5.75	4.60	4.70	5.50
8	5.40	5.40	5.50	5.50	6.10	5.50	5.75	6.20	5.70	4.50	4.70	5.50
9	5.40	5.40	5.50	5.80	5.50	5.80	5.70	6.20	5.60	4.90	4.80	5.50
10	5.40	5.40	5.50	5.80	5.60	6.20	5.65	6.20	5.60	4.85	4.85	5.50
11	5.40	5.40	5.50	5.90	5.60	6.10	5.65	6.15	5.60	5.00	5.00	5.30
12	5.40	5.50	5.50	5.90	5.60	6.00	5.55	5.85	5.60	5.00	5.00	5.20
13	5.40	5.50	5.50	5.60	5.00	6.20	5.50	5.90	5.50	4.80	5.00	5.00
14	5.40	5.50	5.50	5.90	5.00	6.30	5.60	5.85	5.30	4.70	4.80	5.10
15	5.40	5.50	5.50	5.90	5.20	7.15	5.60	5.75	5.30	5.00	4.50	5.20
16	5.40	5.50	5.50	5.90	5.55	7.00	5.60	5.70	5.20	5.00	4.60	5.10
17	5.40	5.50	5.40	5.80	5.60	7.10	5.55	5.60	5.20	5.00	4.80	5.50
18	5.40	5.50	5.40	5.70	5.85	6.80	5.45	5.80	5.00	5.00	4.80	5.70
19	5.40	5.40	5.40	5.70	5.80	6.55	5.35	5.90	5.10	5.00	5.00	5.70
20	5.40	5.40	5.40	5.70	6.00	6.70	5.25	5.90	5.80	5.00	5.00	5.70
21	5.40	5.40	5.40	6.40	6.00	6.60	5.30	5.85	5.15	5.00	5.00	5.80
22	5.40	5.40	5.40	6.70	6.50	6.65	4.80	5.90	5.00	5.00	4.50	5.80
23	5.40	5.40	5.40	6.80	6.50	6.40	4.50	6.00	5.00	5.00	4.75	5.80
24	5.40	5.40	5.70	6.80	6.80	6.50	4.50	5.95	4.70	4.90	4.80	5.80
25	5.30	5.40	5.70	6.80	6.60	6.20	4.60	5.85	4.70	4.90	4.90	5.60
26	5.30	5.40	5.70	6.90	6.40	5.55	4.70	5.75	4.80	4.80	5.00	5.70
27	5.30	5.40	5.70	6.80	6.40	5.00	4.90	5.50	5.00	4.50	4.70	5.65
28	5.30	5.40	5.60	6.75	6.30	5.30	5.30	5.50	5.20	4.00	4.80	5.50
29	5.30	.....	5.60	6.60	6.30	5.50	5.40	5.65	5.20	4.50	5.00	5.40
30	5.30	.....	5.50	6.50	6.80	5.70	5.50	5.95	5.20	4.80	5.10	5.70
31	5.30		5.50	.....	6.65	.....	5.55	6.00	.....	4.50	.....	5.40

BEAR CREEK NEAR MORRISON, COLO.

The station was established April 16, 1899, and is located just above the little town of Morrison. It is described in Water-Supply Paper No. 49, page 284. As in previous years, the station is maintained through cooperation with the Denver Union Water Company, the observations being made by S. Hebrew, an employee of the company. Results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 321. A measurement was made by A. L. Fellows, on May 10, 1901, the discharge found being 88 second-feet for a gage height of 4.60 feet.

Daily gage height, in feet, of Bear Creek near Morrison, Colo., for 1901.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.50	4.65	4.40	4.15	1.95	2.90	1.40	1.60	1.35
2	1.15	4.80	4.45	4.05	1.85	2.65	1.35	1.65	1.35
3	1.70	4.75	4.65	3.90	2.20	2.55	1.35	1.65	1.45
4	1.85	4.45	4.40	3.75	3.70	2.45	1.30	1.55	1.55
5	1.70	4.45	4.25	3.55	2.90	2.60	1.30	1.45	1.55
6	1.75	4.60	4.25	3.45	2.55	2.35	1.55	1.45	1.60
7	2.05	4.35	4.40	3.45	2.65	2.20	1.75	1.35	1.70
8	1.80	4.25	4.40	3.35	2.75	2.10	1.65	1.35	.....
9	1.90	4.15	4.35	3.25	2.55	2.00	1.55	1.55	.....
10	1.75	4.25	4.45	3.55	2.35	1.85	1.55	1.65	.....
11	1.50	4.35	4.35	3.45	2.15	1.75	1.65	1.55	.....
12	2.05	4.25	4.25	3.55	1.95	1.70	1.90	1.45	.....
13	1.95	4.15	4.20	3.35	1.80	1.60	2.05	1.45	.....
14	2.00	4.15	4.45	3.30	1.65	1.50	1.95	1.35	.....
15	2.65	4.25	4.95	3.25	1.55	1.45	1.85	1.25	.....
16	2.10	4.25	1.45	3.05	1.60	1.40	1.75	1.15	.....
17	1.80	4.50	4.45	2.95	1.70	1.35	1.65	1.15	.....
18	2.10	4.35	4.45	2.75	2.00	1.30	1.65	1.05	.....
19	2.30	4.55	4.45	2.55	3.25	1.60	1.60	1.15	.....
20	2.90	4.70	4.35	2.45	2.90	1.45	1.60	1.30	.....
21	4.10	4.85	4.35	2.35	2.80	1.40	1.70	1.35	.....
22	4.20	4.70	4.65	2.25	2.55	1.40	1.70	1.40	.....
23	4.40	4.30	4.65	2.05	2.40	1.30	1.60	1.40	.....
24	4.25	4.50	4.50	1.85	2.25	1.30	1.60	1.30	.....
25	4.20	4.50	4.45	2.30	2.15	1.30	1.50	1.15	.....
26	4.50	4.45	4.40	2.15	1.95	1.40	1.50	1.25	.....
27	4.40	4.45	4.35	2.90	1.80	1.45	1.60	1.15	.....
28	4.45	4.35	4.25	2.55	2.30	1.40	1.70	1.15	.....
29	4.60	4.35	4.25	2.35	3.65	1.35	1.70	1.25	.....
30	5.60	4.25	4.15	2.15	4.55	1.35	1.65	1.45	.....
31	.....	4.25	.....	2.05	3.75	.....	1.65	.....	.....

CLEAR CREEK AT FORKSCREEK, COLO.

The station was established May 29, 1899, and has been continued through the irrigation seasons of 1899, 1900, and 1901. It is described in Water-Supply Paper No. 49, page 285. During the last two years the observer has been E. A. Schrum, station agent at Forkscreek, who has voluntarily made the readings. Results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 322. During 1901 one measurement was made by A. L. Fellows on May 8, when the discharge was 231 second-feet and the gage height 2.25 feet.

Daily gage height, in feet, of Clear Creek at Forkscreek, Colo., for 1901.

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1		3.35	3.55	2.30	2.20	1.60	1.60
2		3.45	3.50	2.25	2.20	1.60	1.60
3		3.35	3.40	2.20	2.15	1.60	1.50
4		3.30	3.40	2.70	2.10	1.60	1.50
5		3.30	3.30	2.55	2.10	1.70	1.60
6		3.25	3.30	2.60	2.00	1.70	1.60
7		3.35	3.20	2.80	2.00	1.70	1.60
8	2.30	3.45	3.20	2.75	2.00	1.70	1.50
9	2.30	3.60	3.10	2.65	1.90	1.70	1.50
10	2.55	3.65	3.15	2.55	1.90	1.70	1.50
11	2.60	3.65	3.10	2.50	1.90	1.75	1.35
12	2.75	3.50	3.15	2.50	1.90	1.75	1.30
13	2.80	3.50	3.10	2.40	1.90	1.65	1.30
14	2.80	3.55	3.00	2.40	1.90	1.60	1.35
15	2.95	3.50	2.90	2.40	1.90	1.75	1.40
16	3.00	3.25	2.80	2.30	1.90	1.80	1.40
17	3.10	3.30	2.90	2.35	1.90	1.70	1.40
18	3.25	3.30	2.85	2.30	1.90	1.70	1.30
19	3.45	3.30	2.80	2.20	1.90	1.70	1.30
20	3.80	3.35	2.80	2.35	1.90	1.70	1.30
21	3.85	3.45	2.70	2.20	1.90	1.70	1.35
22	3.75	3.55	2.70	2.20	1.80	1.70	1.40
23	3.65	3.70	2.70	2.20	1.80	1.70	1.40
24	3.60	3.70	2.75	2.20	1.80	1.70	1.40
25	3.50	3.65	2.80	2.15	1.70	1.70	1.40
26	3.45	3.60	2.70	2.10	1.70	1.70	1.45
27	3.55	3.60	2.70	2.10	1.70	1.70	1.45
28	3.67	3.50	2.60	2.10	1.70	1.70	1.45
29	3.60	3.50	2.60	2.30	1.70	1.70	1.40
30	3.55	3.60	2.50	2.30	1.65	1.70	1.40
31	3.50		2.40	2.25		1.60	

SOUTH BOULDER CREEK NEAR MARSHALL, COLO.

This station, which was established in April, 1888, and which has been maintained during a portion of each year since, except during 1893 and 1894, is located at the mouth of the canyon from which the stream issues about 3 miles west of the Colorado and Southern Railway station at Marshall. It is described in Water-Supply Paper No. 49, page 286. The observer during 1901 was Miss Blanche Barber, who lives near by. Results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 323. During 1901 one measurement was made by John E. Field on May 3, when the discharge was 128 second-feet for a gage height of 2 feet.

Daily gage height, in feet, of South Boulder Creek near Marshall, Colo., for 1901.

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	.....	1.05	2.00	2.50	2.35	1.60	1.40
2	.....	1.15	2.10	2.45	2.35	1.55	1.40
3	.....	1.15	2.05	2.50	2.45	1.60	1.35
4	.....	1.05	1.85	2.35	2.35	1.75	1.30
5	.....	1.15	1.80	2.35	2.30	1.65	1.30
6	.....	1.10	1.80	2.35	2.25	1.60	1.30
7	.....	1.25	1.75	2.35	2.15	1.65	1.30
8	.....	1.20	1.65	2.45	2.15	1.75	1.30
9	.....	1.20	1.70	2.55	2.10	1.65	1.30
10	.....	1.10	1.75	2.55	2.10	1.60	1.30
11	.....	1.15	1.90	2.55	2.15	1.60	1.25
12	.....	1.20	1.85	2.45	2.15	1.55	1.25
13	.....	1.20	1.95	2.45	2.05	1.50	1.20
14	.....	1.35	1.85	2.60	1.95	1.50	1.20
15	.....	1.25	1.85	2.65	1.95	1.50	1.20
16	.....	1.30	1.95	2.45	1.90	1.50	1.20
17	.....	1.10	2.20	2.35	1.90	1.50	1.20
18	.....	1.35	1.70	2.35	1.80	1.50	1.20
19	.....	1.45	.....	2.35	1.80	1.50	1.20
20	.....	1.55	.....	2.45	1.80	1.50	1.20
21	.....	1.85	.....	2.50	1.80	1.50	1.20
22	.....	1.90	.....	2.60	1.80	1.45	1.20
23	.....	2.00	.....	2.60	1.80	1.45	1.20
24	.....	2.00	.....	2.65	1.80	1.45	1.15
25	.....	2.00	.....	2.60	1.75	1.40	1.15
26	.....	1.80	2.35	2.60	1.75	1.40	1.15
27	.....	1.75	2.30	2.55	1.75	1.40	1.15
28	.....	1.80	2.50	2.45	1.70	1.40	1.15
29	.....	1.95	2.45	2.40	1.65	1.45	.....
30	.....	2.00	2.50	2.40	1.65	1.45	.....
31	1.05	.....	2.60	.....	1.60	1.45	.....

BOULDER CREEK NEAR BOULDER, COLO

The gaging station is located 1½ miles above the town of Boulder, where the stream issues from the mountains, and is described in Water-Supply Paper No. 49, page 287. The observer for 1901 was Mrs. Carrie Osgood, who lives near by. The results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 324. During 1901 one measurement was made by John E. Field on May 2, when the discharge was 244 second-feet for a gage height of 1.65 feet.

Daily gage height, in feet, of Boulder Creek near Boulder, Colo., for 1901.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	0.20	1.70	2.05	2.15	1.48	0.80	0.32	0.22	0.20
2	.20	1.72	2.00	2.18	1.42	.68	.35	.25	.22
3	.22	1.78	2.05	2.18	1.40	.68	.32	.25	.22
4	.30	1.67	2.05	2.05	1.70	.60	.30	.25	.18
5	.30	1.60	1.95	1.90	1.42	.65	.32	.25	.12
6	.20	1.65	1.90	1.85	1.35	.62	.35	.25	.12
7	.25	1.65	2.00	1.85	1.30	.60	.38	.28	.15
8	.38	1.40	2.05	1.75	1.32	.60	.45	.28	.12
9	.38	1.35	2.20	1.75	1.25	.60	.42	.28	.12
10	.35	1.30	2.20	1.78	1.18	.62	.32	.25	.18
11	.40	1.35	2.15	1.75	1.15	.60	.32	.28	.15
12	.45	1.50	2.20	1.72	1.12	.55	.48	.28	.12
13	.50	1.55	2.20	1.68	.98	.52	.48	.32	.12
14	.50	1.65	2.30	1.68	.90	.50	.45	.32	.10
15	.45	1.70	2.20	1.78	.90	.48	.40	.32	.15
16	.40	1.90	2.15	1.70	1.00	.48	.35	.30	.12
17	.42	1.90	1.95	1.68	1.08	.48	.30	.28	.12
18	.42	2.00	1.90	1.65	.98	.45	.32	.25	.18
19	.58	2.05	2.00	1.55	.90	.52	.35	.25	.18
20	.75	2.30	2.15	1.55	.75	.45	.32	.22	.18
21	1.10	2.45	2.40	1.58	.75	.45	.30	.22	.20
22	1.25	2.60	2.60	1.50	.70	.45	.32	.20	.22
23	1.25	2.65	2.85	1.52	.72	.45	.32	.22	.20
24	1.30	2.38	2.60	1.50	.68	.42	.32	.18	.15
25	1.38	2.20	2.45	1.80	.62	.40	.32	.18	.12
26	1.38	2.10	2.52	1.60	.62	.40	.30	.22	.12
27	1.38	2.10	2.28	1.75	.62	.42	.30	.20	.10
28	1.42	2.12	2.15	1.70	.62	.42	.32	.18	.10
29	1.48	2.10	2.12	1.48	.62	.35	.32	.18	.12
30	1.60	2.10	2.15	1.45	.95	.35	.30	.20	.15
31	.....	2.12	.....	1.42	1.00	.....	.40	.....	.15

ST. VRAIN CREEK NEAR LYONS, COLO.

The station at Lyons is about a half mile southeast of the town, and is below the junction of the north and south forks. It is described in Water-Supply Paper No. 49, page 288. Records of the flow of the creek at or near Lyons have been kept since April, 1888, except during the years 1893 and 1894, but the station was not put in its present condition until May 5, 1899, since which date records have been kept throughout each irrigation season. Results of measurements for 1900 are published in the Twenty-second Annual Report, Part IV, page 325. Supply ditch diverts water above the station, and its discharge should be added to that of the creek in order to obtain the total run-off of the basin. The observer during the year 1901 was L. H. Dickson, commissioner of the St. Vrain water district, who kept up the readings during the irrigation season. Weekly records of the discharge at this point have been furnished to the Longmont papers. One measurement was made during 1901 by J. E. Field, May 2, when the discharge was 278 second-feet for a gage height of 3.20 feet.

Daily gage height, in feet, of St. Vrain Creek near Lyons, Colo., for 1901.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	1.80	3.20	3.45	3.60	2.85	2.42	2.02	2.00
2	1.90	3.20	3.45	3.55	2.80	2.40	2.02	2.00
3	2.00	3.10	3.60	3.55	2.95	2.40	2.02	2.00
4	2.00	3.05	3.30	3.55	3.00	2.60	2.00	2.00
5	1.90	2.70	3.35	3.45	3.10	2.45	2.00	1.90
6	1.93	2.80	3.25	3.32	3.00	2.45	2.12	1.90
7	1.95	2.75	3.35	3.30	3.05	2.45	2.12	1.90
8	1.98	2.75	3.55	3.30	2.95	2.45	2.12	1.90
9	1.95	2.75	3.90	3.30	3.15	2.40	2.10	1.90
10	1.90	2.80	3.80	3.38	3.00	2.30	2.10	1.95
11	1.90	3.04	3.85	3.42	2.92	2.30	2.10	1.95
12	1.95	3.05	3.60	3.42	2.82	2.25	2.10	1.95
13	2.15	3.08	3.55	3.25	2.72	2.20	2.12	1.90
14	2.25	3.04	3.58	3.15	2.70	2.18	2.12	1.85
15	2.45	3.04	3.65	3.20	2.68	2.18	2.10	1.80
16	2.35	3.05	3.45	3.22	2.65	2.18	2.10	1.90
17	2.25	3.30	3.30	3.15	2.65	2.15	2.05	1.90
18	2.40	3.30	3.38	2.95	2.65	2.15	2.05	1.90
19	2.50	3.35	3.55	2.92	2.65	2.15	2.00	1.90
20	2.68	3.60	3.60	2.95	2.60	2.10	2.00	1.85
21	2.85	3.90	3.60	3.20	2.60	2.10	2.00	1.85
22	3.00	3.90	3.80	3.10	2.60	2.10	2.05	1.90
23	3.00	3.50	4.00	3.05	2.60	2.10	2.05	1.95
24	3.05	3.45	3.95	2.92	2.50	2.80	2.05	1.90
25	3.05	3.55	3.85	3.10	2.50	2.05	2.00	1.85
26	2.95	3.45	3.80	3.10	2.50	2.02	2.00	1.80
27	2.95	3.68	3.75	3.30	2.47	2.00	1.95	1.85
28	2.90	3.75	3.65	3.10	2.45	2.00	1.95	1.85
29	2.90	3.80	3.65	3.05	2.45	2.05	1.95	1.85
30	3.10	3.55	3.70	3.00	2.45	2.03	2.00	1.95
31	.....	3.60	.....	2.90	2.42	.....	2.00	.....

Daily gage height, in feet, of supply ditch near Lyons, Colo., for 1901.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	0.10	0.80	1.20	1.22	0.40	0.40	0.30	0.30
2	.10	.80	.90	1.00	.40	.40	.30	.30
3	.10	.80	1.00	.75	.45	.40	.30	.30
4	.10	.80	.80	.70	.60	.40	.30	.30
5	.10	.80	.90	.50	.72	.40	.30	.30
6	.10	1.25	.90	.58	.55	.40	.30	.30
7	.10	1.25	.67	.52	.55	.40	.30	.30
8	.10	1.25	.75	.50	.62	.40	.30	.30
9	.10	1.25	1.30	.40	.70	.40	.30	.30
10	.10	1.25	1.35	.70	.55	.40	.30	.30
11	.10	.85	1.45	.65	.55	.40	.30	.30
12	.10	.85	1.15	.60	.40	.40	.30	.30
13	.10	.85	1.00	.45	.40	.40	.30	.30
14	.10	.60	1.00	.35	.35	.40	.30	.30
15	.10	.60	1.00	.40	.35	.40	.30	.30
16	.30	.60	.70	.60	.35	.40	.30	.30
17	.30	1.20	1.15	.65	.40	.35	.30	.30
18	.30	1.00	1.10	.88	.40	.30	.30	.30
19	.30	1.00	1.10	.80	.40	.30	.30	.30
20	.30	1.45	1.25	.85	.40	.30	.30	.30
21	.30	1.50	1.30	.85	.50	.30	.30	.30
22	.30	1.50	1.15	.40	.50	.30	.30	.30
23	.30	1.20	1.00	.20	.50	.30	.30	.30
24	.30	1.20	1.15	.30	.50	.30	.30	.30
25	.60	1.20	1.30	.40	.40	.30	.40	.45
26	.80	1.20	1.40	.40	.40	.30	.40	.45
27	.80	1.20	1.50	.80	.40	.30	.40	.45
28	.80	1.35	1.45	.75	.40	.30	.40	.45
29	.80	1.52	1.42	.43	.40	.30	.40	.55
30	.80	1.25	1.20	.43	.40	.30	.30	.30
31	.....	1.25	.....	.40	.40	.....	.30	.....

BIG THOMPSON CREEK NEAR ARKINS, COLO.

Records of the flow of this stream were begun in April, 1888, and have been maintained for a portion of each year since, with the exception of the years 1893 and 1894. The station was established at its present location on April 1, 1899. The only diversion above the gaging station is Handy ditch, a record of the gage heights of which is kept by the water commissioner of the district, J. M. Wolaver, who has also kept the records of Big Thompson Creek at this point during the first part of 1901. An estimate of the discharge for the entire season was made by E. G. McKinney, who succeeded Mr. Wolaver. The appended table of daily discharge includes the flow of Buckhorn Creek and of the Big Thompson and Handy ditches. A description of the station was published in Water-Supply Paper No. 49, page 290. Results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 326. A measurement was made May 1, by J. E. Field, when the discharge was found to be 226 second-feet for a gage height of 1.30 feet.

Daily discharge, in second-feet, of Big Thompson Creek near Arkins, Colo., for 1901.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Day.	Apr.	May.	June.	July.	Aug.	Sept.
1	.....	283	898	975	255	110	17	.....	764	740	425	255	60
2	.....	283	876	975	255	110	18	.....	793	740	425	220	55
3	.....	283	919	851	255	95	19	.....	855	616	225	220	55
4	.....	305	919	811	355	110	20	.....	918	810	355	255	55
5	.....	310	643	741	355	95	21	.....	862	864	355	255	55
6	.....	252	620	625	355	95	22	40	866	990	355	220	55
7	.....	243	620	583	355	110	23	43	977	1,092	308	180	55
8	.....	208	626	557	506	110	24	55	972	1,143	308	180	55
9	.....	255	865	557	506	110	25	80	922	1,127	308	150	44
10	.....	255	944	761	404	80	26	105	899	882	355	180	44
11	.....	304	1,115	864	370	80	27	132	896	864	355	140	44
12	.....	312	980	761	355	80	28	160	884	810	308	140	44
13	.....	406	895	710	255	80	29	189	891	810	308	140	44
14	.....	355	870	608	255	70	30	283	925	790	308	140	44
15	.....	519	800	557	220	70	31	.....	925	.....	255	140	.....
16	.....	671	910	557	220	60							

CACHE LA POUDRE RIVER NEAR FORT COLLINS, COLO.

This station, which was established in 1884, is about 15 miles above Fort Collins. Since its establishment it has been maintained under the direction of Prof. L. G. Carpenter, of the Colorado State Agricultural College. The records are from the figures published by Professor Carpenter in the daily papers. A description of the station and figures of daily discharge for the year 1900 will be found in Water-Supply Paper No. 49, page 291. Results of measurements for 1900 are published in the Twenty-second Annual Report, Part IV, page 327.

Daily discharge, in second-feet, of Cache la Poudre River near Fort Collins, Colo., for 1901.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.
1		619	2,449	[a]1,455	382	294	109
2		667	2,263	[a]1,362	369	273	103
3		765	2,199	1,289	371	[a]264	100
4		685	2,010	1,164	377	265	93
5		737	1,870	1,062	380	[a]242	110
6		737	1,695	1,028	[a]374	[a]219	116
7		744	1,733	997	368	[a]196	122
8		768	1,951	914	483	[a]173	126
9		825	2,240	800	510	[a]150	136
10		999	2,182	1,150	443	128	135
11		1,091	2,135	1,083	366	153	133
12		1,205	1,854	1,077	393	138	129
13		1,338	1,753	948	346	134	126
14		1,448	1,823	854	333	134	122
15		1,517	2,127	792	306	134	120
16		1,650	2,123	747	304	134	
17		1,813	2,049	621	304	131	
18		1,959	1,940	600	309	113	
19		2,185	1,970	595	313	111	
20		2,462	1,913	601	314	111	
21		3,850	1,997	578	353	111	
22		5,100	2,087	568	303	110	
23		2,462	2,144	558	274	106	
24	365	2,008	2,136		265	104	
25	434	2,236	2,065		259	102	
26	402	2,321	1,811		290	101	
27	425	2,422	1,675		294	98	
28	399	[a]2,496	1,575		242	100	
29	399	2,570	[a]1,497		269	110	
30	487	2,216	[a]1,425		266	113	
31		2,574		406	301		

[a] Approximated.

SOUTH PLATTE RIVER AT KERSEY, COLO.

This station was established April 27, 1901, at Kersey, a station on the Union Pacific Railroad, about 6 miles east of Greeley, at a bridge 1½ miles north of the railroad station itself. This station was intended to take the place of the one previously maintained at Orchard, Colo. This point was selected on account of the regularity of the channel and the fact that there was a wagon bridge crossing the river from which gagings could be made in high water. It is of particular value owing to the fact that the point is just below all the important tributaries of the South Platte, which derive their supply from the mountain region. It is also at about the point where water could be used to the best advantage for storage in reservoirs along South Platte River in northeastern Colorado. The observer is Edward K. Plumb, who lives near the bridge and visits the rod once each day. The gage rod consists of a vertical 2 by 6 inch timber, 8 feet long, marked in feet and tenths and spiked to the downstream side of the third pile of the bridge from its south end. The initial point for soundings is the right bank, downstream side, the bridge being marked every 10 feet. The right bank is high and not liable to overflow, but the left is low and water spreads over a considerable distance at high stages.

The following discharge measurements were made by John E. Field and A. L. Fellows during 1901:

April 27: Gage height, 3.70 feet; discharge, 1,813 second-feet.
May 14: Gage height, 1.23 feet; discharge, 74 second-feet.
June 21: Gage height, 4.20 feet; discharge, 2,530 second-feet.

Daily gage height, in feet, of South Platte River at Kersey, Colo., for 1901.

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.50	3.70	2.20	1.80	1.80	2.00	2.20	2.40
2	3.30	3.65	2.10	1.80	1.80	2.00	2.20	2.40
3	3.30	3.50	2.10	1.80	1.80	2.00	2.20	2.45
4	3.30	3.50	2.00	1.80	1.80	2.00	2.25	2.50
5	3.20	3.35	1.95	1.80	1.80	2.00	2.30	2.50
6	3.10	3.20	1.90	1.80	1.80	2.00	2.30	2.50
7	2.80	2.50	1.90	1.80	2.50	2.00	2.30	2.50
8	2.50	2.20	1.90	1.80	2.40	2.00	2.30	2.50
9	2.10	2.80	1.90	1.80	2.55	2.10	2.30	2.55
10	1.80	3.00	1.85	1.80	2.70	2.10	2.30	2.55
11	1.60	3.80	1.85	1.80	2.30	2.20	2.30	2.70
12	1.50	4.25	1.80	1.80	2.20	2.35	2.30	2.95
13	1.40	4.00	1.80	1.80	2.15	2.35	2.40	3.40
14	1.25	3.35	1.80	1.80	2.10	2.35	2.45	3.80
15	1.20	3.50	1.80	1.80	2.00	2.35	2.50	3.80
16	1.25	5.95	1.80	1.80	2.00	2.30	2.50	3.80
17	1.25	5.80	1.80	1.80	2.00	2.30	2.50	3.20
18	1.25	5.00	1.80	1.85	2.00	2.30	2.50	2.90
19	2.25	4.50	1.80	1.85	2.00	2.30	2.50	2.90
20	4.50	4.00	1.80	1.85	2.00	2.30	2.45	3.00
21	5.25	4.00	1.80	1.85	2.00	2.30	2.40	3.00
22	6.55	3.95	1.80	1.85	2.00	2.30	2.40	3.00
23	5.20	3.90	1.80	1.90	2.00	2.30	2.40	2.95
24	4.20	3.90	1.80	1.90	2.00	2.30	2.40	2.95
25	4.20	3.90	1.80	1.80	2.00	2.30	2.40	2.90
26	4.00	3.50	1.80	1.80	2.00	2.30	2.40	2.90
27	3.80	2.70	1.80	1.80	1.95	2.30	2.40	2.90
28	3.50	2.50	1.80	1.80	1.95	2.30	2.40	2.90
29	3.50	2.30	1.80	1.80	1.95	2.30	2.40	2.90
30	3.50	2.25	1.80	1.80	2.00	2.30	2.40	2.90
31	3.60	.....	1.80	1.80	.....	2.30	.....	2.90

LOUP RIVER NEAR COLUMBUS, NEBR.

This station is located near the steel bridge of the Union Pacific Railroad just west of Columbus, Nebr., and only a few miles above the mouth of the river. It is described in Water-Supply Paper No. 50, page 306. Results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 328. During 1901 the following discharge measurements were made by O. V. P. Stout and his assistants:

List of discharge measurements of Loup River near Columbus, Nebr.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1901.	*Feet.*	*Sec.-ft.*	1901.	*Feet.*	*Sec.-ft.*
March 31	4.65	3,134	July 14	3.97	1,211
April 21	4.84	3,242	August 11	4.52	[a] 1,710
May 10	4.85	2,615	October 6	4.68	2,354
June 1	4.70	2,023	November 2	5.30	3,229
June 18	5.80	4,861	December 1	4.55	2,618

[a] Approximate.

Daily gage height, in feet, of Loup River near Columbus, Nebr., for 1901.

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1		4.50	4.70	4.60	5.05	4.15	4.50	4.60	4.90
2		4.48	4.70	4.60	5.00	4.10	4.50	4.65	5.10
3		4.50	4.70	4.60	4.90	4.10	4.50	4.65	5.30
4		4.60	4.70	4.70	4.90	4.10	4.57	4.65	5.20
5		4.70	4.70	4.80	4.90	4.10	4.70	4.65	5.10
6		4.80	4.80	4.70	4.70	4.13	4.80	4.65	5.00
7		4.55	4.80	4.70	4.45	4.12	4.90	4.65	4.90
8		4.50	4.85	4.70	4.38	4.12	4.95	4.65	4.80
9		4.50	4.90	4.70	4.30	4.10	4.95	4.70	4.60
10		4.60	4.90	4.70	4.20	4.10	5.10	4.80	4.55
11		4.70	4.80	4.60	4.10	4.52	5.10	4.80	4.55
12		4.80	4.80	4.60	4.10	4.40	5.45	4.80	4.55
13		5.00	4.80	4.60	4.10	4.30	5.55	4.80	4.55
14		5.10	4.70	4.60	3.97	4.45	5.60	4.80	4.60
15		5.20	4.70	4.60	3.95	4.40	5.60	4.80	4.60
16		5.30	4.70	6.45	4.00	4.40	5.60	4.75	4.55
17		5.20	4.60	6.45	4.00	4.40	5.40	4.70	4.55
18		5.00	4.60	5.80	4.00	4.35	5.30	4.70	4.55
19		5.00	4.60	5.90	4.00	4.30	5.10	4.65	4.55
20		5.00	4.65	6.00	4.05	4.27	4.70	4.65	4.55
21		4.85	4.70	6.10	4.40	4.27	4.70	4.65	4.55
22		4.85	4.80	6.05	4.30	4.27	4.70	4.65	4.55
23		4.80	4.75	6.00	4.20	4.30	4.70	4.65	4.55
24	4.60	4.80	4.80	5.90	4.10	4.40	4.70	4.65	4.55
25	4.60	4.70	4.85	5.70	4.00	4.70	4.60	4.70	4.55
26	4.60	4.90	4.90	5.60	3.90	4.55	4.50	4.70	4.55
27	4.50	4.70	4.90	5.45	3.85	4.50	4.50	4.70	4.55
28	4.50	4.90	4.80	5.34	4.00	4.45	4.50	4.70	4.60
29	4.50	4.90	4.80	5.15	3.95	4.45	4.50	4.70	4.60
30	4.45	4.80	4.70	5.10	4.10	4.45	4.55	4.75	4.65
31	4.50		4.60		4.20	4.45		4.90	

PLATTE RIVER NEAR COLUMBUS, NEBR.

This station, which was established in 1895, is located above Meridian bridge, south of Columbus. It is described in Water-Supply Paper No. 50, page 307. Results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 329. During 1901 the following discharge measurements were made by O. V. P. Stout and his assistants:

List of discharge measurements of Platte River near Columbus, Nebr.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1901.	*Feet.*	*Sec.-ft*	1901.	*Feet.*	*Sec.-ft.*
March 31	2.50	1,816	July 14		379
April 21	3.25	4,824	October 6		20
May 10	3.45	6,799	November 2	1.90	978
June 7	3.90	8,241	December 1	1.85	922
June 18	4.35	11,949			

Daily gage height, in feet, of Platte River near Columbus, Nebr., for 1901.

Day.	Mar.	Apr.	May.	June.	July.	Nov.	Day.	Mar.	Apr.	May.	June.	July.	Nov.
1		2.40	2.60	3.90	3.40	1.20	17		5.00	3.30	4.30		1.40
2		2.35	2.60	3.90	3.22	1.90	18		4.90	3.40	4.31		1.40
3		2.35	2.55	3.90	3.06	1.90	19		4.70	3.45	4.35		1.40
4		2.40	2.50	3.85	2.90	1.90	20		4.40	3.45	4.40		1.40
5		3.50	2.50	3.80	2.85	1.80	21		3.25	3.50	4.45		1.40
6		3.40	2.60	3.80	2.80	1.75	22		3.25	3.50	4.45		1.40
7		3.40	2.70	3.85	2.79	1.70	23		3.20	3.60	4.45		1.40
8		3.40	2.80	3.85	2.50	1.60	24	2.60	3.20	3.50	4.30		1.50
9		3.45	2.90	3.85	2.40	1.60	25	2.60	3.10	3.50	4.10		1.60
10		3.50	3.10	3.85	2.22	1.60	26	2.70	3.00	3.50	4.00		1.65
11		3.60	3.20	3.90	2.00	1.60	27	2.70	2.80	3.50	3.95		1.70
12		3.80	3.20	3.95	([a])	1.55	28	2.60	2.75	3.60	3.90		1.75
13		4.60	3.20	4.00		1.50	29	2.50	2.75	3.70	3.80		1.80
14		4.80	3.25	4.10		1.50	30	2.50	2.60	3.80	3.60		1.85
15		4.80	3.30	4.20		1.45	31	2.50		3.90			
16		5.10	3.30	4.30		1.40							

[a] Sand around gage, water standing in pools, July 12–November 1.

ELKHORN RIVER NEAR NORFOLK, NEBR.

Two gaging stations are maintained on this river, one at Norfolk and the other at Arlington, Nebr. The station at the former place is near the Thirteenth street bridge, 2 miles south of the town and above the mouth of the North Fork of Elkhorn River. It is described in Water-Supply Paper No. 50, page 308. Results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 329. During 1901 the following discharge measurements were made by O. V. P. Stout and his assistants:

March 21: Gage height, 2.30 feet; discharge, 466 second-feet.
May 13: Gage height, 2.55 feet; discharge, 550 second-feet.
June 27: Gage height, 6.69 feet; discharge, 3,445 second-feet.
July 31: Gage height, 1.36 feet; discharge, 215 second-feet.
December 30: Gage height, — feet; discharge, 252 second-feet.

Daily gage height, in feet, of Elkhorn River near Norfolk, Nebr., for 1901.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	2.22	2.74	1.65	5.03	1.42	.90	1.81	1.81
2	2.25	2.72	1.60	4.82	1.31	.89	1.80	1.80
3	2.28	2.69	1.60	4.45	1.29	.89	1.77	1.82
4	2.34	2.46	1.75	4.00	1.24	.87	1.76	1.84
5	2.36	2.30	1.71	4.42	1.23	.87	1.75	1.85
6	2.34	2.44	1.60	4.32	1.20	.85	1.75	1.87
7	2.34	3.24	1.63	4.11	1.17	.85	1.75	1.88
8	2.34	3.03	1.67	3.95	1.15	.92	1.76	1.93
9	2.35	3.04	1.65	3.85	1.14	1.05	1.76	1.95
10	2.36	2.84	1.85	3.65	1.12	1.06	1.76	1.93
11	2.37	2.73	1.76	3.42	1.10	1.25	1.75	1.92
12	2.42	2.64	1.80	3.05	1.03	1.53	1.76	1.90
13	2.46	2.55	1.85	2.79	1.00	1.83	1.78	1.87
14	2.64	2.63	2.05	2.65	.99	1.92	1.81	1.85
15	2.62	2.29	2.18	2.53	.95	1.97	1.83	1.85
16	2.74	2.29	3.06	2.40	.94	1.96	1.85	1.85
17	2.94	2.25	3.24	2.33	.89	1.85	1.85	1.87
18	3.04	2.20	3.42	2.14	1.14	1.81	1.85	1.87
19	3.04	2.20	4.05	1.95	1.12	1.80	1.86	1.87
20	3.06	2.11	4.80	1.90	1.10	1.88	1.87	1.87
21	3.06	2.02	5.18	1.90	1.00	1.87	1.87	1.88
22	3.27	2.00	5.02	1.85	.96	1.86	1.87	1.88
23	3.33	1.95	5.40	1.83	.95	1.85	1.87	1.90
24	3.23	1.85	5.62	1.80	.93	1.83	1.89	1.83
25	2.22	1.90	6.17	1.73	.92	1.82	1.87	1.83
26	3.22	1.85	6.53	1.70	.95	1.81	1.8	1.85
27	3.16	1.85	6.67	1.65	.97	1.83	1.8	1.85
28	3.16	1.85	6.67	1.62	.99	1.84	1.8	1.81
29	2.99	1.85	6.00	1.60	.95	.....	1.8	1.81
30	2.84	1.80	5.70	1.54	.92	.....	1.81	1.81
31	.....	1.75	.....	1.52	.91	.....	.....	.....

ELKHORN RIVER NEAR ARLINGTON, NEBR.

This station, which was established by Glenn E. Smith on April 28, 1899, is located at the wagon bridge 1 mile west of the town of Arlington. It is described in Water-Supply Paper No. 50, page 309. Results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 330. During 1901 the following discharge measurements were made by O. V. P. Stout:

June 17: Gage height, 2.37 feet; discharge, 905 second-feet.
June 24: Gage height, 6.76 feet; discharge, 3,989 second-feet.
July 12: Gage height, 2.99 feet; discharge, 1,320 second-feet.
July 30: Gage height, 1.15 feet; discharge, 564 second-feet.
November 9: Gage height, 1.90 feet; discharge, 706 second-feet.

Daily gage height, in feet, of Elkhorn River near Arlington, Nebr., for 1901.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	2.20	2.66	1.66	6.01	1.07	0.39	1.50	1.51
2	2.22	2.63	1.64	5.74	1.03	.41	1.54	1.44
3	2.25	2.50	1.60	5.23	1.00	.44	1.53	1.58
4	2.30	2.46	1.62	4.98	.99	.45	1.62	1.68
5	2.40	2.57	1.88	4.76	.96	.38	1.63	1.72
6	2.45	2.82	1.60	4.23	.94	.48	1.53	1.78
7	2.46	3.85	1.51	4.03	.90	.40	1.41	1.86
8	2.49	3.95	1.60	3.78	.91	.65	1.39	1.82
9	2.45	4.07	1.66	3.57	.92	.76	1.37	1.90
10	2.44	3.81	2.10	3.37	.87	.91	1.39	1.92
11	2.42	3.88	2.28	3.16	.87	.92	1.48	1.94
12	2.38	4.00	2.22	3.02	.81	1.10	1.55	1.88
13	2.45	3.66	2.23	2.83	.74	1.36	1.58	1.87
14	2.45	3.22	2.15	2.67	.77	1.42	1.60	1.86
15	2.54	2.92	2.24	2.50	.74	1.49	1.61	1.79
16	2.68	2.75	2.37	2.35	.71	1.56	1.69	1.78
17	2.76	2.55	2.34	2.22	.68	1.64	1.74	1.74
18	2.78	2.45	3.26	2.10	.70	1.63	1.70	1.66
19	2.92	2.34	3.80	1.99	.68	1.75	1.63	1.64
20	3.01	2.25	5.28	1.78	.62	1.60	1.59	1.66
21	3.08	2.15	6.06	1.75	.64	1.50	1.56	1.65
22	3.07	2.08	6.67	1.70	.62	1.37	1.52	1.61
23	3.11	2.05	7.17	1.61	.78	1.31	1.53	1.64
24	3.06	1.98	6.74	1.55	.61	1.39	1.51	1.65
25	2.95	1.96	6.38	1.45	.58	1.40	1.45	1.62
26	2.87	1.92	6.05	1.40	.60	1.35	1.49	1.64
27	2.88	1.89	5.93	1.35	.54	1.34	1.51	1.60
28	2.77	1.85	5.98	1.38	.55	1.35	1.52	1.61
29	2.72	1.84	6.10	1.28	.51	1.40	1.45	1.58
30	2.68	1.75	6.09	1.15	.46	1.42	1.48	1.54
31	.....	1.70	.....	1.12	.42	.....	1.50	.....

KANSAS RIVER DRAINAGE.

REPUBLICAN RIVER NEAR SUPERIOR, NEBR.

This station, which was established June 20, 1896, is located about 1 mile west of Superior. Discharge measurements are made from the highway bridge, thus determining the total amount of water passing over the dam and through the mill race. The discharge of the mill race is measured also, and is deducted from the total discharge, in order to determine the amount passing over the dam. The station is described in Water-Supply Paper No. 50, page 312. Results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 332. During 1901 the following measurements were made by O. V. P. Stout and others:

List of discharge measurements of Republican River near Superior, Nebr.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1901.	*Feet.*	*Sec.-ft.*	1901.	*Feet.*	*Sec.-ft.*
April 14	1.57	1,189	September 10	2.28	2,237
May 29	.41	250	November 15	.90	370
July 27	.....	4.5			

List of discharge measurements of mill race near Superior, Nebr.

Date.	Center depth.	Discharge.	Date.	Center depth.	Discharge.
1901.	*Feet.*	*Sec.-ft.*	1901.	*Feet.*	*Sec.-ft.*
April 14	3.70	20.9	September 10	5.00	16.8
May 29	2.40	139	November 15	2.90	72

Daily gage height, in feet, of Republican River near Superior, Nebr., for 1901.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	1.21	1.21	0.47	0.38	1.00	(a)	1.15	1.10
2	1.21	1.12	.53	.51	(a)	(a)	1.83	1.50
3	1.24	1.11	.52	.43	(a)	(a)	1.50	.91
4	1.32	1.12	.42	.45	(a)	(a)	1.00	.90
5	1.30	.98	.40	.32	(a)	(a)	1.13	1.00
6	1.47	1.12	.40	.32	(a)	2.12	1.00	.84
7	1.46	1.09	.42	.35	(a)	1.91	1.00	.82
8	1.43	1.05	.47	.31	(a)	2.02	1.08	1.00
9	1.47	.85	.50	−.17	(a)	2.41	1.10	.85
10	1.48	.81	.45	−.33	(a)	2.25	.93	.80
11	1.50	.91	.40	−1.00	1.42	3.10	.93	.93
12	1.52	.99	.39	−1.00	1.38	3.45	.93	.90
13	1.52	.85	.39	−1.50	.30	2.75	.95	.98
14	1.57	.90	.49	−1.50	1.30	2.10	.90	.98
15	1.73	.88	.82	−2.00	−.17	2.58	.92	.98
16	1.79	.90	.25	(a)	(a)	2.19	.90	.88
17	1.71	.72	.36	(a)	(a)	2.01	.93	.80
18	1.65	.75	.50	(a)	(a)	1.08	.90	.97
19	1.68	1.01	.69	(a)	(a)	1.07	.92	.93
20	1.69	.70	.75	(a)	(a)	1.07	.80	.94
21	1.61	.82	1.09	(a)	(a)	1.05	.88	1.00
22	1.51	.61	1.00	(a)	(a)	1.05	.90	.93
23	1.42	.80	1.05	(a)	(a)	1.04	.78	1.00
24	1.35	.65	1.12	(a)	(a)	1.03	.88	.80
25	1.31	.65	.97	(a)	(a)	1.02	.90	1.00
26	1.28	.69	.88	(a)	(a)	1.02	.78	1.00
27	1.31	.62	.78	(a)	(a)	1.02	.76	.98
28	1.30	.45	.73	(a)	(a)	1.01	.80	1.03
29	1.27	.41	.69	(a)	(a)	1.40	.90	.98
30	1.25	.59	.65	(a)	(a)	1.20	1.10	.95
31	.....	.59	.....	.37	(a)	.....	.98	.....

[a] River too low to read gage.

Daily center depth, in feet, of mill race near Superior, Nebr., for 1901.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	3.42	.....	2.82	1.82	1.40	.95	1.10	1.10
2	3.57	.....	2.90	2.22	.61	.90	1.04	1.40
3	3.52	.....	2.92	2.32	.60	1.30	1.02	.62
4	3.57	.....	2.73	2.22	.60	.90	1.00	.64
5	3.58	2.52	2.70	2.12	.61	.90	1.10	.94
6	3.75	3.12	2.82	2.13	.52	4.82	1.00	.62
7	3.75	3.09	2.73	2.20	.50	4.19	1.10	.60
8	3.62	3.11	2.80	2.12	.68	4.40	1.08	.94
9	3.73	2.58	2.72	1.65	.60	4.95	.95	.84
10	3.74	2.42	2.69	1.50	.69	5.00	.95	.53
11	3.80	3.17	2.62	1.18	3.82	6.00	.90	.98
12	3.82	3.29	2.60	.93	3.78	5.65	.96	.90
13	3.67	3.29	2.62	.86	3.70	5.12	.93	.93
14	3.80	3.30	2.71	1.20	3.71	4.80	.90	.90
15	3.99	3.45	3.11	.92	2.13	5.00	.80	.90
16	3.98	2.82	2.40	.58	1.30	4.50	.86	.85
17	3.98	2.90	2.70	.50	1.40	2.19	.88	.50
18	4.02	2.82	3.01	.45	.75	1.90	.86	.90
19	3.76	3.51	2.98	.57	.68	1.85	.82	.90
20	3.91	2.50	3.01	.55	.72	1.80	.60	.90
21	3.78	3.20	3.56	.40	1.11	1.60	.86	.95
22	3.71	2.72	1.00	.33	1.21	1.55	.98	.90
23	3.51	2.50	3.25	.30	1.00	1.45	.75	.98
24	3.40	3.00	3.35	.40	1.72	1.40	.83	.53
25	3.40	2.98	3.17	.30	.80	1.25	.90	1.00
26	3.32	3.02	3.01	.45	.60	1.28	.76	.98
27	3.40	3.00	2.80	.50	.59	1.23	.48	.91
28	.....	2.58	2.63	.55	.55	1.12	.73	1.03
29	.....	2.47	2.35	.40	.48	1.40	.84	.93
30	.....	3.10	2.41	.52	.61	1.25	1.10	.94
31	.....	2.32	.....	2.45	1.11	.....	.92	.....

MISCELLANEOUS DISCHARGE MEASUREMENTS IN NEBRASKA.

Date.	Stream.	Locality.	Hydrographer.	Discharge.
1901.				*Sec. feet.*
Apr. 6	Niobrara	Niobrara City	O. V. P. Stout	1,591
Apr. 7	Verdigris Creek	Above Niobrara City	do	105
Do	Niobrara	Niobrara City	do	2,115
May 13	North Fork Elkhorn	Norfolk	C. B. Channel	550
May 20	Salt Creek	Lincoln	O. V. P. Stout	44
July 12	Big Blue	Wymore	do	235
July 17	South Platte	North Platte	do	Dry.
July 20	Republican	McCook	do	Dry.
Do	do	Culbertson	do	Dry.
July 23	Beaver	Geneva	do	75
July 31	North Fork Elkhorn	Norfolk	C. B. Channel	149
Aug. 1	Minichaduza	Valentine	O. V. P. Stout	27
Aug. 11	Platte	Fremont	do	1,152
Aug. 27	Niobrara	Niobrara City	do	990
Aug. 30	Beaver	Geneva	do	86
Oct. 3	Birdwood Creek	Sec. 15, T. 15, R. 33	B. E. Forbes	170
Nov. 14	Minichaduza	Valentine	do	25
Nov. 21	Cedar	Fullerton	do	309
Do	Prairie Creek	Sec. 20, T. 16, R. 5	do	7
Dec. 3	Beaver	Albion	do	91

REPUBLICAN RIVER AT JUNCTION, KANS.

This station is described in Water-Supply Paper No. 50, page 313. Results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 333. During 1901 the following measurements were made by W. G. Russell:

May 17: Gage height, 3.80 feet; discharge, 761 second-feet.
September 19: Gage height, 5.40 feet; discharge, 2,082 second-feet.
October 15: Gage height, 3.75 feet; discharge, 544 second-feet.
December 3: Gage height, 3.60 feet; discharge, 491 second-feet.

Daily gage height, in feet, of Republican River at Junction, Kans., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.70	3.50	4.30	4.20	4.30	3.40	3.50	2.60	2.40	4.00	3.50	3.60
2	3.70	3.60	4.40	4.30	4.30	3.40	3.40	2.60	2.40	4.00	3.50	3.60
3	3.70	3.80	4.60	4.30	4.20	3.30	3.40	2.60	2.40	3.90	3.55	3.60
4	3.70	3.80	4.60	4.30	4.20	3.30	3.30	2.70	2.40	3.90	3.50	3.60
5	3.70	3.80	4.50	4.30	4.20	3.30	3.30	2.70	2.40	4.00	3.40	3.60
6	3.70	3.80	4.50	4.40	4.10	3.20	3.30	2.60	2.40	4.00	3.40	3.60
7	3.70	3.80	4.20	4.30	4.10	3.40	3.20	2.60	2.40	4.00	3.50	3.60
8	3.70	3.80	5.00	4.30	4.10	3.40	3.20	2.60	2.50	3.90	3.55	3.60
9	3.70	3.80	4.60	4.30	4.10	3.50	3.10	2.60	2.70	3.80	3.60	3.60
10	3.70	3.80	4.50	4.40	4.10	3.50	3.00	2.60	2.80	3.70	3.50	3.50
11	3.70	3.80	4.40	4.60	4.10	3.50	3.00	2.60	2.80	3.80	3.50	3.60
12	3.70	3.80	4.30	5.70	4.10	3.40	2.80	2.60	2.60	3.70	3.60	3.70
13	3.70	3.80	4.20	6.80	4.10	3.40	2.80	2.60	4.60	3.70	3.60	3.70
14	3.70	3.80	4.10	5.80	3.80	3.30	2.70	2.60	5.00	3.75	3.60	3.70
15	3.70	3.80	4.10	5.10	3.80	3.30	2.70	2.60	6.00	3.70	3.50	3.80
16	3.70	3.80	4.10	5.00	3.80	3.30	2.70	2.50	5.70	3.65	3.60	3.80
17	3.60	3.80	4.10	5.00	3.80	3.30	2.70	2.50	5.60	3.60	3.60	3.85
18	3.60	3.80	4.20	5.00	3.80	3.20	2.60	2.50	5.40	3.60	3.55	3.85
19	3.60	3.80	4.20	4.90	3.80	3.20	2.60	2.50	5.20	3.60	3.60	3.85
20	3.50	3.80	4.10	4.90	3.80	3.30	2.60	2.50	5.00	3.60	3.60	3.85
21	3.50	3.80	4.10	4.90	3.70	3.30	2.60	2.50	4.80	3.50	3.50	3.85
22	3.50	3.80	4.10	4.90	3.80	3.40	2.60	2.50	4.40	3.50	3.50	3.85
23	3.40	3.90	4.10	4.80	4.00	3.40	2.60	2.40	4.30	3.45	3.60	3.85
24	3.50	4.00	4.20	4.70	4.20	3.50	2.60	2.40	4.20	3.40	3.60	3.85
25	3.40	4.30	4.40	4.70	4.20	3.60	2.60	2.40	4.00	3.40	3.60	3.85
26	3.40	4.30	4.30	4.60	4.00	3.60	2.60	2.40	4.00	3.50	3.55	3.85
27	3.40	4.20	4.20	4.50	3.80	3.60	2.60	2.40	4.00	3.50	3.50	3.85
28	3.50	4.10	4.20	4.50	3.70	3.60	2.60	2.40	4.00	3.55	3.55	3.80
29	3.50	.....	4.20	4.40	3.60	3.50	2.60	2.40	3.90	3.50	3.60	3.80
30	3.50	.....	4.30	4.30	3.50	3.50	2.60	2.40	3.90	3.50	3.60	3.80
31	3.40	.....	4.20	.....	3.40	.....	2.60	2.40	.....	3.45	.....	3.80

SOLOMON RIVER NEAR NILES, KANS.

This station is described in Water-Supply Paper No. 50, page 314. Records of discharge measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 334. During 1901 the following discharge measurements were made by W. G. Russell:

May 17: Gage height, 5.40 feet; discharge, 165 second-feet.
September 20: Gage height, 5.70 feet; discharge, 194 second-feet.
October 17: Gage height, 4.70 feet; discharge, 59 second-feet.

Daily gage height, in feet, of Solomon River near Niles, Kans., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4.90	4.50	5.20	5.10	5.60	5.00	4.40	3.80	4.90	4.70	4.80	4.60
2	4.80	4.60	5.10	5.30	5.40	4.90	4.30	3.80	5.50	4.60	4.80	4.80
3	4.90	4.50	5.40	5.40	5.30	4.90	4.30	3.80	5.30	4.90	4.60	4.40
4	4.90	4.90	5.30	5.40	5.30	5.00	4.30	3.80	5.00	4.90	4.60	4.90
5	4.90	4.40	5.70	5.70	5.20	4.70	4.30	3.80	5.00	4.70	4.20	4.70
6	4.90	4.50	6.00	6.00	5.50	4.80	4.30	3.80	4.70	4.60	5.50	4.80
7	5.00	4.60	5.90	5.70	5.50	4.80	4.30	3.70	4.60	4.70	5.50	4.70
8	5.00	4.70	5.60	5.70	5.30	5.20	4.20	3.90	4.70	4.60	5.50	4.90
9	5.00	4.50	5.20	5.50	5.30	7.60	4.30	3.80	4.70	4.60	5.40	5.00
10	5.00	4.40	5.30	5.40	5.10	9.60	4.20	3.80	4.60	4.90	5.10	4.80
11	5.00	4.60	5.30	8.00	5.00	6.60	4.20	4.10	4.80	4.80	5.10	4.90
12	5.10	4.90	5.10	11.60	5.00	5.40	4.00	4.00	4.70	4.80	5.00	4.90
13	5.10	4.80	5.20	13.40	5.00	5.50	4.00	4.40	7.50	4.60	5.00	4.60
14	5.10	5.00	5.30	11.40	4.90	5.40	4.00	4.40	12.00	4.20	5.20	4.50
15	5.00	5.00	5.20	9.90	5.00	5.20	3.90	3.90	8.50	4.70	5.00	4.50
16	5.00	4.90	5.20	9.50	5.10	5.10	3.90	3.90	8.60	4.50	5.00	4.80
17	5.00	5.00	5.10	7.90	5.50	4.90	4.00	3.80	6.60	4.70	5.10	5.00
18	5.00	4.90	5.20	7.00	5.40	4.70	4.20	3.90	6.20	4.50	5.00	4.90
19	5.00	5.10	5.00	6.70	5.50	5.40	3.80	3.80	6.00	4.40	4.80	4.80
20	5.00	5.00	5.00	6.60	5.80	5.40	3.80	3.90	5.70	4.30	4.90	5.00
21	4.90	4.90	5.00	6.40	5.20	5.20	3.80	3.80	5.70	4.30	4.90	4.90
22	4.80	5.10	5.10	6.00	5.00	5.00	3.80	3.90	5.60	4.40	4.90	4.80
23	4.70	4.90	6.10	5.90	5.30	4.90	3.80	3.80	5.50	4.70	4.70	4.70
24	4.90	4.90	6.40	6.00	5.50	4.80	3.80	3.70	5.30	4.30	4.80	4.70
25	4.80	5.10	5.50	5.90	6.20	4.60	3.80	3.80	5.20	4.60	4.90	4.60
26	4.90	5.30	5.30	5.70	5.40	4.70	3.70	3.80	5.00	4.70	4.70	4.60
27	4.80	5.60	5.20	5.70	5.20	4.30	4.30	3.90	4.90	4.60	4.90	4.70
28	4.60	5.00	5.10	5.50	5.10	4.30	3.90	3.80	4.80	4.20	4.80	4.60
29	4.30	.....	5.00	5.40	5.00	4.60	3.80	4.50	5.00	4.20	4.70	4.70
30	4.70	.....	5.20	5.40	5.00	4.50	3.80	3.80	4.90	4.80	4.60	4.80
31	4.70	.....	5.10	...	4.90	.....	3.80	3.70	.....	4.80	.....	4.80

SALINE RIVER NEAR SALINA, KANS.

This station is described in Water-Supply Paper No. 50, page 315. Results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 335. During 1901 the following discharge measurements were made by W. G. Russell:

March 31: Gage height, 4.10 feet; discharge, 55 second-feet.
August 30: Gage height, 4.90 feet; discharge, 110 second-feet.
October 17: Gage height, 3.70 feet; discharge, 23 second-feet.

Daily gage height, in feet, of Saline River near Salina, Kans., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4.00	4.30	4.60	4.40	4.40	4.10	3.70	3.00	4.40	3.60	3.50	3.90
2	3.90	4.20	4.90	4.50	4.40	4.00	3.80	3.00	3.90	3.60	3.90	3.80
3	(a)	4.10	4.80	4.70	4.00	4.00	3.60	3.00	3.70	3.80	3.80	3.90
4	3.90	4.20	4.60	5.00	4.40	16.80	3.50	3.20	3.90	3.80	3.90	3.90
5	(a)	(a)	4.30	5.20	4.50	10.40	3.20	3.30	3.70	3.90	3.70	3.80
6	(a)	4.00	4.50	7.20	4.30	7.80	3.30	3.30	3.70	3.90	3.70	3.90
7	3.70	(a)	4.10	6.10	4.20	6.10	3.30	3.00	3.50	3.80	4.10	4.00
8	3.80	4.00	4.30	5.00	4.30	18.50	3.20	3.30	4.00	3.70	4.00	4.10
9	(a)	(a)	4.30	4.80	4.30	15.90	3.10	3.30	3.80	3.60	3.90	4.00
10	(a)	4.10	4.20	4.70	4.20	8.90	3.30	3.20	3.70	3.70	3.70	3.90
11	3.90	(a)	4.20	8.70	4.20	6.50	3.00	3.50	3.50	3.50	3.80	3.80
12	3.90	4.00	4.00	21.50	4.10	5.50	3.20	3.50	3.70	3.70	4.00	4.10
13	3.90	(a)	3.80	19.80	4.10	5.80	3.20	3.50	4.00	3.80	3.80	4.00
14	3.90	4.20	4.00	13.60	4.00	5.40	3.20	3.30	4.00	3.70	3.50	a 4.10
15	3.90	4.10	4.30	11.00	4.10	4.90	3.30	3.40	3.90	3.70	3.80	a 4.00
16	3.70	4.10	4.20	9.80	5.80	4.60	3.00	3.30	3.70	3.40	3.80	(a)
17	3.90	4.20	4.20	8.40	6.60	4.30	3.20	3.40	3.50	3.70	4.00	a 4.10
18	3.70	4.20	4.10	7.00	4.70	4.40	3.30	3.30	3.50	3.70	3.90	(a)
19	3.80	4.50	4.10	6.40	5.30	7.20	3.20	3.10	4.10	3.70	3.90	a 4.00
20	4.00	4.50	4.10	6.00	5.50	6.00	3.10	3.30	4.40	3.70	3.90	(a)
21	4.00	3.90	4.10	5.60	5.00	4.70	3.00	3.30	4.00	3.70	3.60	a 4.00
22	4.00	4.10	4.20	5.40	4.70	4.50	3.00	3.70	4.00	3.70	3.80	a 4.00
23	3.80	4.20	4.60	5.20	7.00	4.10	3.00	3.60	4.00	3.60	3.80	a 3.90
24	3.70	4.50	4.50	5.00	5.60	4.00	3.20	3.40	3.90	3.60	4.00	a 4.00
25	3.80	4.60	4.20	4.80	4.90	3.90	3.00	3.50	3.70	3.80	3.90	3.80
26	4.10	4.70	4.10	4.90	5.40	3.90	3.10	3.50	3.70	3.70	4.10	3.80
27	4.10	4.80	4.20	4.80	4.70	3.90	3.10	3.50	3.80	3.80	3.90	3.80
28	4.20	4.70	4.20	4.70	4.80	3.90	3.10	5.30	3.90	3.80	4.00	3.80
29	4.20	.....	4.00	4.60	4.50	3.80	3.10	5.30	3.80	4.00	3.80	3.70
30	4.10	.....	4.10	4.50	4.10	3.40	2.90	4.70	3.60	3.60	3.80	3.80
31	4.20	.....	4.20	.....	4.20	.....	3.10	4.50	.....	3.60	.....	3.80

[a] Frozen.

SMOKY HILL RIVER AT ELLSWORTH, KANS.

This station is described in Water-Supply Paper No. 50, page 316. Results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 336. During 1901 the following measurements were made by W. G. Russell:

March 29: Gage height, 1.00 foot; discharge, 25 second-feet.
August 23: Gage height, 1.00 foot; discharge, 19 second-feet.

Daily gage height, in feet, of Smoky Hill River at Ellsworth, Kans., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	0.90	(a)	1.20	1.00	1.40	1.05	0.90	0.60	0.90	1.00	0.80	0.75
2	.90	0.95	1.20	1.05	1.35	1.00	.90	.55	.85	1.00	.80	.75
3	.90	(a)	1.10	1.05	1.35	1.00	.80	.55	.80	1.00	.80	.75
4	.90	(a)	1.10	1.15	1.30	1.70	.80	.50	.80	1.00	.80	.75
5	.90	(a)	1.10	1.10	1.25	1.20	.80	.50	.80	1.20	.75	.80
6	(a)	(a)	1.20	1.10	1.20	1.15	.80	.50	.80	1.20	.75	.80
7	1.00	(a)	1.20	1.10	1.20	1.10	.75	.50	.75	1.30	.75	.80
8	(a)	(a)	1.15	1.15	1.20	1.25	.75	.60	1.00	1.20	.70	.80
9	(a)	(a)	1.10	1.10	1.15	1.20	.70	.60	1.00	1.30	.70	.80
10	(a)	1.00	1.10	1.20	1.15	1.15	.70	.60	1.00	1.30	.70	.80
11	(a)	(a)	1.10	1.90	1.15	1.10	.65	1.60	1.20	1.35	.70	.80
12	1.60	(a)	1.15	3.00	1.10	1.15	.65	1.60	1.60	1.30	.70	.80
13	1.50	1.30	1.20	2.25	1.10	1.15	.60	1.55	1.60	1.25	.70	.75
14	(a)	(a)	1.20	2.05	1.05	1.10	.60	1.60	1.70	1.20	.65	(a)
15	(a)	(a)	1.10	2.05	1.00	1.10	.60	1.70	1.60	1.20	.65	(a)
16	1.60	1.60	1.05	2.00	1.05	1.10	.60	1.60	1.60	1.20	.65	(a)
17	(a)	1.50	1.05	1.95	1.10	1.05	.60	1.40	1.55	1.15	.65	(a)
18	1.60	1.40	1.05	1.90	1.20	1.40	.60	1.30	1.55	1.15	.65	(a)
19	(a)	1.50	1.00	1.75	1.10	1.30	.65	1.20	1.55	1.10	.65	(a)
20	(a)	1.70	1.00	1.70	1.10	1.30	.65	1.15	1.50	1.05	.70	(a)
21	1.20	1.70	.95	1.70	1.10	1.25	.60	1.30	1.50	1.00	.70	(a)
22	1.15	1.70	.95	1.60	1.25	1.25	.60	1.20	1.40	.95	.70	(a)
23	1.10	1.70	.95	1.50	1.25	1.25	.60	1.20	1.35	.95	.70	a 1.00
24	1.10	1.80	.95	1.40	1.20	1.20	.55	1.15	1.30	.90	.75	a 1.00
25	1.10	1.80	1.00	1.30	1.20	1.20	.55	1.15	1.25	.90	.75	b 1.20
26	1.05	1.60	1.00	1.25	1.20	1.20	.55	1.10	1.20	.85	.75	(a)
27	1.05	1.40	1.00	1.25	1.20	1.15	.55	1.10	1.20	.85	.75	(a)
28	1.00	1.30	.95	1.20	1.15	1.15	.50	1.00	1.20	.80	.70	(a)
29	1.00	.....	1.00	1.50	1.15	1.10	.50	1.00	1.10	.80	.70	1.20
30	1.00	.....	1.00	1.45	1.10	1.00	.65	.95	1.10	.80	.70	1.20
31	1.00	.....	1.00	.....	1.10	.....	.60	.95	.....	.85	.....	1.20

[a] Frozen. [b] Running on top of ice.

BLUE RIVER NEAR MANHATTAN, KANS.

This station is described in Water-Supply Paper No. 50, page 317. The results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 337. During 1901 the following discharge measurements were made by W. G. Russell:

April 1: Gage height, 5.00 feet; discharge, 917 second-feet.
May 20: Gage height, 5.20 feet; discharge, 1,072 second-feet.
September 20: Gage height, 4.90 feet; discharge, 804 second-feet.
October 14: Gage height, 4.20 feet; discharge, 563 second-feet.
December 2: Gage height, 3.70 feet; discharge, 312 second-feet.

Daily gage height, in feet, of Blue River near Manhattan, Kans., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4.05	4.30	5.35	5.10	5.00	4.50	3.90	4.60	3.70	3.80	4.10	3.90
2	4.25	4.40	5.35	5.20	5.00	4.40	4.00	4.30	3.70	3.80	4.20	3.70
3	4.30	4.50	5.30	5.30	4.90	4.30	4.00	4.00	3.60	3.80	4.50	3.70
4	4.40	4.70	5.10	5.80	4.90	4.40	4.10	4.30	3.60	3.80	5.10	3.80
5	4.40	4.40	5.00	6.10	5.20	5.70	4.10	4.20	3.60	3.70	5.70	3.80
6	4.55	4.60	4.90	6.60	5.40	5.40	3.90	4.00	3.50	3.70	5.10	3.70
7	4.55	4.55	4.90	8.50	7.20	5.60	3.90	3.90	3.50	3.80	4.50	4.10
8	4.50	4.50	4.70	6.40	6.70	5.40	4.30	3.80	3.60	3.80	4.50	4.00
9	4.30	4.60	4.90	5.70	5.90	4.90	4.60	3.70	3.70	3.80	4.40	4.00
10	4.35	4.60	4.90	5.40	5.60	4.60	4.50	3.70	3.90	3.80	4.20	3.90
11	4.50	4.65	4.80	5.30	5.30	4.50	4.30	3.90	3.70	3.90	4.20	3.90
12	4.50	4.60	4.80	7.40	5.20	4.50	4.20	4.10	3.50	3.90	4.10	3.90
13	4.50	4.60	4.80	15.50	5.10	6.00	4.10	6.50	3.60	4.00	4.00	3.90
14	4.55	4.65	4.85	12.50	5.00	5.50	4.10	6.60	4.20	4.00	4.00	3.80
15	4.55	4.60	5.15	8.20	5.00	4.80	3.90	7.80	4.30	4.00	4.00	3.80
16	4.60	4.65	5.00	7.30	5.00	4.50	3.90	6.30	4.50	4.10	3.90	3.80
17	4.50	4.75	4.75	6.80	4.90	4.40	4.00	5.40	4.30	4.20	3.90	3.80
18	4.65	5.45	4.60	6.40	6.80	4.50	3.80	5.40	4.60	4.00	4.00	3.70
19	4.70	7.10	4.80	6.20	5.80	4.40	3.70	5.00	5.10	4.00	4.00	3.80
20	4.70	9.05	4.70	6.00	5.70	4.30	3.70	4.50	4.90	3.90	4.00	3.90
21	4.55	7.75	4.70	5.80	5.60	4.30	3.70	4.30	4.40	3.90	4.00	3.90
22	4.55	7.90	4.75	5.70	5.10	4.20	3.60	4.20	4.30	3.80	4.00	4.00
23	4.40	7.85	5.00	5.60	4.90	4.30	3.60	4.20	4.20	3.80	3.90	4.10
24	4.15	8.85	7.50	5.60	6.00	4.90	3.60	4.20	4.20	3.70	4.00	4.20
25	4.10	9.25	8.05	5.50	5.50	4.60	3.60	4.10	4.10	3.70	3.90	4.40
26	4.10	7.20	7.15	5.40	5.30	4.80	3.50	4.00	4.10	3.80	3.90	4.40
27	4.20	5.30	6.15	5.30	4.90	4.90	3.60	3.90	4.00	4.20	3.90	4.40
28	4.20	5.60	5.60	5.30	4.70	4.60	3.70	3.90	3.90	4.20	3.90	4.30
29	4.30	------	5.20	5.20	4.70	4.00	3.70	3.80	3.90	4.20	3.90	4.30
30	4.30	------	5.20	5.10	4.60	3.90	3.80	3.70	3.90	4.20	3.90	4.30
31	4.30	------	5.10	------	4.50	------	4.20	3.70	------	4.10	------	4.30

KANSAS RIVER AT LECOMPTON, KANS.

This station is described in Water-Supply Paper No. 50, page 318. Records of discharge during 1900 will be found in the Twenty-second Annual Report, Part IV, page 338. During 1901 the following discharge measurements were made by W. G. Russell:

May 24: Gage height, 3.20 feet; discharge, 3,234 second-feet.
August 15: Gage height, 2.30 feet; discharge, 749 second-feet.
October 13: Gage height, 2.70 feet; discharge 1,438 second-feet.

Daily gage height, in feet, of Kansas River at Lecompton, Kans., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.60	2.60	4.90	3.75	4.65	3.10	3.10	2.20	3.40	4.00	2.10	2.40
2	2.50	2.60	4.75	3.75	4.45	3.10	3.00	2.20	3.40	3.90	2.15	2.40
3	2.50	2.60	4.70	4.05	4.30	3.10	3.00	2.20	3.30	3.90	2.00	2.40
4	2.50	2.60	4.65	4.40	4.20	3.10	3.00	2.20	3.30	3.80	2.00	2.40
5	2.50	2.60	4.60	6.30	4.05	3.05	2.90	2.20	3.20	3.80	2.20	2.40
6	2.50	2.60	4.50	9.70	4.00	3.00	2.90	2.20	3.20	3.70	2.35	2.30
7	2.60	2.60	4.45	8.50	4.00	3.05	2.75	2.20	3.20	3.60	2.55	2.30
8	2.65	2.60	4.40	7.25	4.15	3.20	2.65	2.10	3.20	3.60	2.65	2.30
9	2.80	2.60	4.30	6.75	4.40	3.20	2.60	2.10	3.10	3.50	2.80	2.30
10	2.80	2.60	4.25	5.75	4.35	3.25	2.50	2.10	3.05	3.50	2.80	2.30
11	2.90	2.60	4.20	5.30	4.25	3.30	2.45	2.10	3.00	3.40	2.80	2.30
12	3.00	2.50	4.15	5.90	4.30	3.45	2.30	2.10	3.00	3.40	2.75	2.30
13	3.00	2.50	4.10	9.00	4.30	3.60	2.20	2.00	3.45	2.70	2.70	2.30
14	3.00	2.50	4.00	10.00	4.20	3.75	2.20	2.00	3.70	2.70	2.70	2.30
15	2.95	2.50	3.95	10.00	4.20	3.80	2.20	2.00	3.80	2.70	2.60	5.20
16	2.90	2.50	3.90	8.85	4.15	3.80	2.10	2.70	4.00	2.65	2.60	5.30
17	2.90	2.50	3.90	7.80	4.10	3.70	2.10	3.25	4.40	2.60	2.60	4.50
18	2.90	2.50	3.80	7.40	4.00	3.65	2.05	3.70	4.60	2.65	2.60	4.20
19	2.90	2.50	3.80	7.30	4.00	3.60	2.00	3.80	4.60	2.50	2.60	3.00
20	2.80	2.70	4.00	6.80	4.00	3.50	2.00	3.80	4.40	2.50	2.60	2.80
21	2.80	3.20	4.15	6.20	3.80	3.45	2.40	3.70	4.30	2.50	2.50	2.40
22	2.80	4.60	4.25	6.15	3.65	3.40	2.40	3.70	4.30	2.45	2.50	2.30
23	2.80	5.30	4.50	6.00	3.50	3.40	2.30	3.70	4.20	2.40	2.50	2.30
24	2.70	5.30	4.55	5.90	3.40	3.35	2.30	3.60	4.20	2.40	2.50	2.30
25	2.70	5.30	4.65	5.60	3.30	3.25	2.30	3.60	4.20	2.30	2.50	2.30
26	2.70	5.30	4.85	5.30	3.30	3.25	2.30	3.60	4.10	2.30	2.50	2.20
27	2.70	5.10	5.30	5.10	3.30	3.20	2.30	3.50	4.00	2.30	2.50	2.20
28	2.70	5.00	5.80	5.10	3.25	3.10	2.30	3.50	4.00	2.20	2.40	2.20
29	2.70	.....	5.90	5.00	3.20	3.10	2.30	3.45	4.00	2.20	2.40	2.20
30	2.70	.....	5.25	4.85	3.20	3.10	2.30	3.40	4.00	2.20	2.40	2.20
31	2.70	.....	3.90	.....	3.15	.....	2.30	3.40	.....	2.10	.....	2.20

ARKANSAS RIVER DRAINAGE.

ARKANSAS RIVER AT GRANITE, COLO.

This station is located at the wagon bridge 250 feet from the railroad station at Granite, Colo., and is described in Water-Supply Paper No. 37, page 257. Previous records of gage height were kept at this station during 1897, 1898, and 1899. A measurement was made April 18, 1901, by A. L. Fellows, when the discharge was 124 second-feet for a gage height of 2.60 feet.

Daily gage height, in feet, of Arkansas River at Granite, Colo., for 1901.

Day.	April.	May.	Day.	April.	May.	Day.	April.	May.
1	(a)	3.20	11	3.40	1.40	21	3.15	.....
2	(a)	2.90	12	3.45	1.90	22	3.35	.....
3	5.10	2.70	13	3.60	2.00	23	3.10	.....
4	4.60	2.70	14	3.45	1.90	24	3.60	.....
5	4.30	2.10	15	3.35	2.80	25	3.40	.....
6	4.45	1.00	16	4.10	.....	26	2.95	.....
7	4.50	1.00	17	4.60	.....	27	3.20	.....
8	4.15	1.00	18	2.60	.....	28	3.10	.....
9	3.80	1.00	19	2.75	.....	29	3.30	.....
10	3.10	1.25	20	3.05	.....	30	3.20	.....

[a] Frozen.

ARKANSAS RIVER AT SALIDA, COLO.

This station is located at the footbridge near the railroad shops at Salida, Colo., and is described in Water Supply-Paper No. 50, page 322. It was established April 15, 1895, and has been maintained

during a portion of each year since. A new inclined gage rod was put in place during the spring of 1901 by J. E. Field, consisting of a 6 by 6 inch oak timber fastened to the north trestle of the bridge, the graduations being extended by marks on the trestle above the timber. On July 31 the gage was lowered and set farther out into the stream. The gage heights are published by the Weather Bureau official in the Denver morning papers. Results of measurements for 1900 were published in the Twenty-Second Annual Report, Part IV, page 340. During 1901 the following measurements were made by J. E. Field and A. L. Fellows:

April 17: Gage height, 0.40 feet; discharge, 221 second-feet.
May 7: Gage height, 1.20 feet; discharge, 566 second-feet.
May 10: Gage height, 1.23 feet; discharge, 134 second-feet.
September 11: Gage height, 0.55 feet; discharge, 422 second-feet.

Daily gage height, in feet, of Arkansas River at Salida, Colo., for 1901.

Day.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	0.40	1.75	2.20	2.10	1.45	0.80	0.25	0.40
2	.45	1.90	1.75	2.00	1.50	.90	.20	.40
3	.60	1.70	1.70	1.90	1.15	.90	.30	.35
4	.70	1.55	1.70	1.75	1.10	.95	.30	.30
5	.60	1.50	1.80	1.55	1.10	.90	.30	.30
6	.70	1.45	1.65	1.45	1.10	.85	.40	.40
7	.75	1.25	1.60	1.40	1.20	.70	.40	.40
8	.80	1.20	1.85	1.25	1.25	.60	.40	.40
9	.70	1.20	2.55	1.20	1.30	.60	.50	.40
10	.45	1.20	2.30	1.20	1.30	.60	.40	.40
11	.40	1.20	2.30	1.20	1.20	.60	.50	.40
12	.40	1.35	2.05	1.10	1.15	.50	.50	.40
13	.40	1.60	2.10	1.05	1.05	.50	.50	.40
14	.45	1.75	2.15	.85	.90	.50	.40	.40
15	.50	1.95	2.20	.80	.85	.50	.30	.45
16	.50	2.00	2.05	.70	.80	.40	.30	.50
17	.50	2.05	1.75	.65	.80	.40	.30	.50
18	.40	2.40	1.80	.55	.80	.40	.30	.45
19	.40	2.80	1.75	.50	.80	.40	.30	.40
20	.55	3.65	1.90	.50	.70	.40	.30	.30
21	.75	3.75	2.00	.45	.75	.30	.30	.30
22	.65	3.55	2.00	.40	.70	.30	.30	.30
23	.85	2.60	2.35	.30	.70	.30	.40	.30
24	.95	2.20	2.45	.30	.80	.30	.40	.30
25	1.30	2.20	2.60	.40	.80	.30	.45	.30
26	1.50	2.25	2.60	.50	.80	.30	.50	.30
27	1.55	2.55	2.50	.65	.80	.30	.50	.30
28	1.60	2.60	2.30	.75	.70	.30	.50	.30
29	1.60	2.65	2.20	.70	.80	.30	.40	.30
30	1.70	2.50	2.20	.65	.90	.30	.40	.30
31	.....	2.50	.....	1.40	.80	.....	.40	.....

ARKANSAS RIVER NEAR CANYON, COLO.

This station is located at the Hot Springs Hotel, 1½ miles west of Canyon and a short distance below the mouth of Grape Creek. It is described in Water-Supply Paper No. 50, page 323. It was established in 1889, and records have been kept since that time, thus furnishing most valuable data of the discharge of the river. The station is of special importance, being located at the mouth of the canyon and at a point practically above all of the irrigation ditches except the Canyon City ditch (sometimes called the North Side ditch) and the South Canyon ditch (sometimes called the South Side ditch), both

of which head above the station. Gagings made on April 17 showed that the discharges of the North and South Side ditches were 31 and 32 second-feet, respectively. Similarly, on May 7 they were found to carry 35 second-feet each, and on September 12, 44 and 31 second-feet, respectively. Results of measurements for 1900 will be found in the Twenty-Second Annual Report, Part IV, page 341. During 1901 the following measurements of discharge were made by A. L. Fellows and J. E. Field:

April 17: Gage height, 2.50 feet; discharge, 335 second-feet.
May 7: Gage-height, 2.85 feet; discharge, 552 second-feet.
September 12: Gage-height, 2.30 feet; discharge, 350 second-feet.

The total flow of the river on these dates, including that of the ditches, amounted to 398, 622, and 425 second-feet, respectively.

Daily gage height, in feet, of Arkansas River near Canyon, Colo., for 1901.

Day	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	.....	.....	2.10	3.30	4.95	4.30	2.60	3.10	2.00	2.00	.....
2	.....	2.30	2.30	2.10	3.35	4.80	4.20	2.60	2.75	2.10	2.00	.....
3	.....	.....	.....	2.35	3.55	4.80	4.00	2.60	2.65	2.10	2.00	.....
4	.....	.....	.....	2.45	2.75	4.70	3.80	3.50	2.70	2.20	.....	.....
5	2.40	.....	.....	2.40	3.00	4.55	3.60	3.00	2.70	2.20	.....	.....
6	.....	.....	.....	2.40	3.00	4.50	3.55	3.00	2.40	2.20	.....	.....
7	.....	.....	.....	2.70	3.00	4.45	3.30	3.25	2.40	2.30	.....	2.10
8	.....	.....	.....	2.75	2.95	4.55	3.25	3.60	2.40	2.30	.....	.....
9	.....	2.30	2.10	2.80	2.60	4.75	3.30	3.60	2.40	2.30	.....	.....
10	.....	.....	.....	2.65	2.70	4.80	3.25	3.35	2.40	2.30	2.00	.....
11	.....	.....	.....	2.60	2.80	4.75	3.20	3.20	2.30	2.30	.....	.....
12	2.40	.....	.....	2.55	2.90	4.55	3.20	3.05	2.20	2.40	.....	.....
13	.....	.....	.....	2.25	3.10	4.45	3.05	2.90	2.20	2.30	.....	.....
14	.....	.....	.....	2.40	3.20	4.55	3.00	2.75	2.20	2.30	.....	2.10
15	.....	.....	.....	2.80	3.70	4.70	3.00	2.70	2.20	2.30	.....	.....
16	.....	2.30	2.10	2.70	3.95	4.40	2.95	2.60	2.10	2.20	.....	.....
17	.....	.....	.....	2.50	3.85	4.25	2.90	2.70	2.10	2.20	2.00	.....
18	.....	.....	.....	2.50	4.30	4.10	2.80	2.70	2.10	2.20	.....	.....
19	2.40	.....	.....	2.50	5.00	4.25	2.80	2.70	2.10	2.20	.....	.....
20	.....	.....	.....	2.90	5.75	4.20	2.70	2.75	2.10	2.20	.....	.....
21	.....	.....	.....	2.95	6.00	4.35	2.55	2.70	2.20	2.10	.....	2.20
22	.....	.....	.....	2.90	5.50	4.25	2.55	2.70	2.20	2.10	.....	.....
23	.....	2.40	2.00	3.05	5.05	4.55	2.50	2.50	2.10	2.10	2.20	.....
24	.....	.....	.....	2.75	4.55	4.65	2.65	2.50	2.10	2.10	.....	.....
25	.....	.....	.....	2.60	4.85	4.70	2.65	2.60	2.00	2.00	.....	.....
26	2.50	.....	.....	2.50	4.80	4.85	2.85	2.60	2.10	2.00	.....	.....
27	.....	.....	.....	2.50	4.80	4.65	3.30	2.65	2.00	2.00	.....	.....
28	.....	.....	.....	2.50	5.00	4.45	3.00	2.55	2.00	2.00	.....	2.20
29	.....	.....	.....	2.65	5.10	4.40	3.00	2.60	2.00	2.00	.....	.....
30	.....	.....	2.00	3.15	5.05	4.40	3.10	4.35	2.00	2.00	2.10	.....
31	.....	.....	2.00	.....	5.00	.....	2.75	2.70	.....	2.00	.....	2.30

ARKANSAS RIVER AT PUEBLO, COLO.

This station, which was established September, 1894, is located at the Union avenue bridge in the city of Pueblo, and is described in Water-Supply Paper No. 50, page 325. This station is an important one, being located near the head of the principal irrigation portion of the valley, only one ditch of importance being taken out above it in the Pueblo district, while considerable water is used in the ditches in the neighborhood of Canyon, which is in another water district. It is upon the gagings made at this point that the water superintendents and commissioners depend for distribution of water to ditches below. The

gage readings during 1901 have been made by T. J. Burrows, water commissioner of the Pueblo water district. Results of measurements for 1900 were published in the Twenty-second Annual Report, Part IV, page 342. During 1901 the following measurements were made by A. L. Fellows, J. E. Field, and C. W. Beach:

List of discharge measurements of Arkansas River at Pueblo, Colo.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1901.	*Feet.*	*Sec.-ft.*	1901.	*Feet.*	*Sec.-ft.*
April 14	2.00	335	May 24	4.00	1,946
May 9	2.30	595	June 11	4.10	2,382
May 4	2.97	1,161	August 26	2.25	603
July 5	3.02	1,206	November 1	1.70	308
May 24	3.90	2,204			

Daily gage height, in feet, of Arkansas River at Pueblo, Colo., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct..	Nov.	Dec.
1	2.00	2.00	1.60	1.55	2.70	5.30	3.55	2.35	3.20	1.60	1.70	1.70
2	2.00	2.00	1.90	1.70	2.90	4.95	4.35	2.20	2.35	1.60	1.70	1.70
3	2.00	2.00	1.90	2.00	3.00	4.75	3.50	2.10	2.30	1.60	1.70	1.70
4	2.00	2.00	1.90	2.00	3.00	4.65	3.30	2.00	2.45	1.60	1.70	1.90
5	2.00	2.00	1.80	2.10	2.70	4.35	3.10	3.40	2.20	1.70	1.65	1.90
6	2.00	2.00	1.80	2.00	2.65	4.25	2.95	2.45	2.10	1.70	1.65	1.90
7	2.00	2.00	1.80	2.00	2.60	4.00	2.80	2.68	2.00	1.70	1.65	1.90
8	2.00	2.00	1.80	2.20	2.45	4.05	2.85	2.68	2.00	1.90	1.65	1.90
9	2.00	2.00	1.80	2.70	2.30	4.15	3.00	3.05	2.20	1.90	1.65	2.00
10	2.00	2.00	1.80	1.85	2.35	4.10	2.95	2.65	2.10	1.90	1.60	2.00
11	2.00	2.00	1.80	2.30	2.40	4.10	2.90	2.70	2.10	1.90	1.70	1.90
12	2.30	2.00	1.80	1.90	2.40	4.10	2.85	2.60	2.10	2.00	1.70	2.20
13	2.30	2.00	1.80	1.65	2.52	3.85	2.75	2.40	2.00	2.00	1.70	2.00
14	2.30	2.00	1.80	1.90	2.68	3.80	2.75	2.20	2.00	2.00	1.70	(a)
15	2.30	2.00	1.80	2.00	3.05	4.30	2.70	2.20	2.00	1.80	1.70	2.00
16	2.30	2.00	1.80	2.20	3.55	4.40	2.60	2.28	2.00	1.80	1.70	2.00
17	2.30	2.00	1.80	2.10	3.42	4.00	2.50	2.60	1.90	1.75	1.70	2.00
18	2.30	2.00	1.80	1.70	3.40	3.70	2.40	2.50	1.80	1.70	2.00	2.25
19	2.00	2.00	1.80	1.90	3.90	3.70	2.35	3.10	1.70	1.70	2.00	2.30
20	2.00	2.00	1.80	2.10	4.80	3.65	1.80	2.62	1.70	1.70	2.00	2.30
21	2.00	2.00	1.70	2.45	7.30	3.80	1.80	2.42	1.70	1.70	2.00	2.30
22	2.00	2.00	1.70	2.30	5.25	3.75	2.20	2.30	1.65	1.70	2.00	2.40
23	2.00	2.00	1.60	2.38	4.80	3.85	2.20	2.25	1.60	1.80	2.00	2.20
24	2.00	2.00	1.60	2.40	4.05	3.82	2.45	2.20	1.60	1.80	1.95	2.30
25	2.00	2.00	1.70	2.30	4.75	4.00	2.45	2.20	1.60	1.70	1.90	2.20
26	2.00	1.70	1.70	2.30	4.50	4.00	2.45	2.30	1.60	1.70	1.90	2.10
27	2.00	1.70	1.70	2.70	4.15	3.95	3.10	2.38	1.60	1.70	1.75	2.00
28	2.00	1.60	1.70	2.70	4.42	3.82	2.80	2.20	1.55	1.70	1.80	2.00
29	2.00	.....	1.70	2.60	4.50	3.49	2.60	2.20	1.50	1.70	1.60	2.00
30	2.00	.....	1.70	2.70	5.00	3.60	2.55	2.60	1.50	1.70	1.70	1.90
31	2.00	.....	1.70	.....	6.90	.....	2.65	3.00	.....	1.70	.....	2.00

[a] River gorged above. About 0.75 second-feet passing Pueblo.

ARKANSAS RIVER NEAR NEPESTA, COLO.

The old station at the wagon bridge near Nepesta, described in previous Water-Supply Papers, was not maintained during the year 1901. Upon May 1, however, another station was established by A. L. Fellows, assisted by C. W. Beach, at the dam and head gate of the Oxford farmers' canal, 1½ miles west of Nepesta. The station consists of the dam crossing the river at the headgate forming a weir, and a gage rod, consisting of a 2 by 6 inch timber, 8 feet long, fastened to an oak pile at the south end of the dam; the location being marked by spikes driven into the pile at each foot mark. The rod is marked in feet and tenths vertically. At low stages the stream may be

measured by wading, but at high stages it is necessary to use the wagon bridge at Nepesta, making the necessary allowances for inflow between the two points; this can readily be done, as the distance is only about a mile. The observer is Mr. Z. Swallow, head-gate keeper of the Oxford farmers' canal. The station will prove of particular value, as it is near the head of irrigation district No. 17, one of the most important on the Arkansas River. Results of measurements for 1900 for the old station will be found in the Twenty-second Annual Report, Part IV, page 343.

During 1901 measurements were made by A. L. Fellows, J. E. Field, and C. W. Beach, as follows:

May 1: Gage height, 0.97 foot; discharge, 672 second-feet.
May 17: Gage height, 1.24 feet; discharge, 1,719 second-feet.
June 7: Gage height, 2.25 feet; discharge, 3,537 second-feet.
August 20: Gage height, 0.88 foot; discharge, 438 second-feet.

Daily gage height, in feet, of Arkansas River near Nepesta, Colo., for 1901.

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Day.	May.	June.	July.	Aug.	Sept.	Oct.
1	0.96	4.75	1.48	0.88	2.12	0.47	17	1.35	2.05	0.88	0.91	0.49	.....
2	.98	2.80	1.60	.82	1.12	.42	18	1.10	1.80	.78	.98	.50	.....
3	1.02	2.50	1.25	.78	.61	.40	19	1.15	1.62	.80	1.20	.48	.....
4	1.02	2.55	.98	.78	.75	.40	20	1.35	1.62	.72	.93	.48	.....
5	.98	2.38	.95	1.48	.73	.48	21	2.30	1.65	.72	.91	.47	.....
6	.93	2.29	1.15	1.39	.71	.50	22	2.10	1.62	.62	.91	.43	.....
7	.92	2.23	1.05	.74	.57	.40	23	1.88	1.52	.59	.91	.42	.....
8	.88	2.15	.85	1.02	.61	.52	24	1.77	1.52	.56	.82	.41	.....
9	.70	2.02	.95	1.27	.83	.68	25	2.22	1.52	.59	.83	.46	.....
10	.85	2.05	.92	1.12	.64	.69	26	1.98	1.50	1.21	.85	.48	.....
11	.85	1.98	.90	1.20	.59	.71	27	1.85	1.54	1.30	.56	.46	.....
12	.85	1.88	.84	1.21	.58	.71	28	1.82	1.52	1.09	.65	.47	.....
13	.95	1.73	.81	1.19	.61	.....	29	1.90	1.50	.72	.65	.51	.....
14	.90	1.74	.90	.81	.59	.....	30	2.45	1.52	.80	.59	.50	.....
15	.96	2.75	.95	.79	.59	.....	31	2.45	.....	.88	2.12	.....	.....
16	1.15	2.35	.93	.75	.59	.....							

ARKANSAS RIVER NEAR ROCKYFORD, COLO.

A new station was established by R. W. Hawley on April 19, 1901, at a point 3½ miles northwest from Rockyford station on the Atchison, Topeka and Santa Fe Railway. A steel cable was stretched across the river and supplied with a car, and an inclined timber gage rod was bolted into the shale on the north side of the river and marked. The bench mark consists of a cut in a tree at the initial point level with a 10-foot mark on the rod. The records were kept up throughout the remainder of the year 1901 through the courtesy of the American Beet Sugar Company, Fred Chappell, agriculturist, taking the reading. The channel is fairly favorable for good results, being at what is known as the old ford. The bottom is of shale and usually free from sand, although filled in to a certain extent at most stages. Gagings may be made either by means of the cable and car or by wading. The point is of especial importance, owing to the fact that it is one of the few places on the Arkansas River where the channel is at all permanent.

During 1901 the following measurements were made by R. W. Hawley and J. E. Field:

April 22: Gage height, 1.60 feet; discharge, 327 second-feet.
May 13: Gage height, 1.75 feet; discharge, 463 second-feet.
June 8: Gage height, 3 feet; discharge, 2,424 second feet.

Daily gage height, in feet, of Arkansas River near Rockyford, Colo., for 1901.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1		1.95	4.90	2.20	1.40	3.00	1.30	1.86	1.50
2		2.00	4.90	2.40	1.40	1.90	1.30	1.80	1.80
3		2.00	4.00	2.30	1.20	1.70	1.30	1.70	1.80
4		2.05	3.90	2.20	1.20	1.50	1.30	1.70	1.50
5		2.10	3.70	2.00	1.20	1.60	1.30	1.70	1.80
6		2.00	3.40	1.90	2.20	2.00	1.50	1.70	1.70
7		1.95	3.20	2.00	1.70	2.00	1.50	1.60	1.70
8		1.90	2.80	1.70	1.60	1.50	1.40	1.60	1.70
9		1.80	2.80	1.40	2.20	1.30	1.40	1.60	1.70
10		1.55	2.90	1.30	2.00	1.40	1.40	1.60	1.70
11		1.45	2.90	1.30	1.90	1.30	1.40	1.60	1.80
12		1.55	2.70	1.30	2.20	1.20	1.40	1.60	1.90
13		1.70	2.50	1.30	2.10	1.20	2.00	1.60	1.90
14	2.70	1.90	2.30	1.30	2.50	1.20	2.00	1.60	1.60
15	2.60	1.80	2.50	1.60	2.50	1.30	1.70	1.60	1.60
16	2.50	2.00	3.30	1.50	2.50	1.20	1.60	1.60	1.70
17	2.50	2.20	3.00	1.40	2.60	1.20	1.60	1.60	1.70
18	2.50	2.10	2.50	1.30	2.60	1.30	1.50	1.70	1.70
19	2.47	2.00	2.40	1.10	2.40	1.40	1.50	1.80	1.70
20		2.20	2.30	1.00	2.80	1.50	1.60	1.80	1.60
21		3.00	2.20	1.00	2.40	1.40	1.60	1.90	1.70
22		3.50	2.10	1.10	2.20	1.30	1.60	1.80	1.80
23	1.70	3.10	2.00	1.30	2.00	1.20	1.60	1.60	1.80
24	1.75	3.00	2.10	1.10	2.00	1.20	1.70	1.80	2.00
25	1.85	2.50	2.20	1.40	2.00	1.30	1.80	1.80	2.00
26	1.85	3.50	2.00	1.60	1.60	1.20	1.80	1.90	2.00
27	1.70	3.00	2.00	2.40	1.60	1.20	1.70	1.80	1.80
28	1.70	3.00	1.90	2.00	1.40	1.30	1.70	1.80	1.50
29	2.00	3.00	2.00	1.60	2.00	1.40	1.60	1.80	1.70
30	2.00	3.20	2.10	1.50	1.60	1.30	1.60	1.70	1.50
31		4.10		1.60	1.60		1.70		1.50

ARKANSAS RIVER NEAR LA JUNTA, COLO.

This station, which is situated at the head of the Fort Lyons canal, is described in Water-Supply Paper No. 37, page 262. The following figures of monthly flow were furnished through the courtesy of C. W. Beach, hydrographer of the Great Plains Water Company, and represent the discharge of the river at this point, inclusive of the amount taken out by the canals. A measurement was made May 3, 1901, by A. L. Fellows, giving a discharge of 361 second-feet at a gage height of 0.80 foot.

Monthly discharge, in second-feet, of Arkansas River near La Junta, Colo., for 1901.

Month.	Discharge.	Month.	Discharge.	Month.	Discharge.
	Sec.-ft.		*Sec.-ft.*		*Sec.-ft.*
January	286	June	2,740	November	274
February	159	July	380	December	252
March	145	August	375		
April	384	September	385	Average	617
May	1,798	October	225		

ARKANSAS RIVER AT PROWERS, COLO.

Records of gage heights were commenced at this station in the spring of 1900. A description of the station is given in Water-Supply Paper No. 50, page 328. The station is of special importance, as it is practically at the head of irrigation district No. 67, only the Colorado and Kansas canal and the Peterson ditch being taken out above in that district. During the greater part of the year little water passes this point, and during low stages water is so valuable that the greatest care should be exercised in its distribution. The observer is D. L. Birge, head-gate keeper of the Colorado and Kansas canal. During 1901 the following measurements were made by A. L. Fellows and J. E. Field:

May 3: Gage height, 0.59 foot; discharge, 204 second-feet.
June 9: Gage height, 1.35 feet; discharge, 1,953 second-feet.

Daily gage height, in feet, of Arkansas River at Prowers, Colo., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	0.20	0.22	0.05	.....	0.15	1.40	0.70	0.20	0.80	0.20	0.20	0.20
2	.20	.22	.05	.....	.15	3.10	.70	.15	.50	.05	.20	.20
3	.20	.25	.05	.....	.20	2.70	.60	.15	.30	.20	.20	.15
4	.20	.22	.....	.....	.25	2.20	.60	.20	.30	.20	.20	.10
5	.25	.22	.....	.....	.20	1.80	.40	.60	.20	.20	.20	.10
6	.20	.22	.....	.....	.15	1.50	.40	.60	.20	.30	.15	.10
7	.40	.28	.....	.....	.20	1.40	.30	.40	.80	.20	.15	.10
8	.25	.30	.....	.....	.20	1.40	.30	.50	.80	.20	.15	.10
9	.20	.32	.....	.....	.20	1.30	.30	.90	.40	.20	.15	.10
10	.20	.32	.....	0.20	.20	.80	.40	1.20	.40	.20	.15	.10
11	.15	.25	.....	.20	.25	.80	.40	1.60	.30	.20	.20	.10
12	.10	.25	.....	.20	.30	1.00	.40	1.00	.20	.05	.20	.10
13	.10	.25	.....	.20	.60	1.50	.40	1.70	.20	.10	.20	.10
14	.10	.30	.....	.15	.50	1.60	.40	1.40	.05	.10	.20	.10
15	.20	.28	.....	.15	.60	1.70	.30	1.00	.20	.10	.20	.10
16	.20	.28	.....	.15	.30	2.10	.30	.80	.20	.10	.30	.10
17	.20	.20	.....	.15	.30	2.20	.30	.80	.20	.05	.30	.15
18	.20	.20	.....	.15	.30	2.00	.30	.70	.20	.05	.30	.10
19	.15	.20	.....	.15	.30	1.50	.20	.60	.30	.....	.30	.10
20	.15	.15	.....	.15	.20	1.50	.20	.40	.20	.....	.20	.05
21	.20	.15	.....	.15	.40	1.40	.20	.30	.05	.....	.20	.05
22	.25	.15	.....	.15	.50	1.20	.15	.30	.05	.10	.20	.20
23	.20	.15	.....	.20	1.40	.80	.15	.30	.10	.10	.20	.30
24	.20	.20	.....	.20	1.00	1.00	.10	.20	.10	.10	.20	.30
25	.15	.15	.....	.20	.70	1.10	.10	.40	.20	.20	.15	.40
26	.20	.10	.....	.20	1.25	1.00	.70	.20	.20	.15	.15	.40
27	.20	.05	.....	.20	1.60	.80	.60	.20	.....	.15	.10	.20
28	.20	.05	.....	.20	1.00	.60	.80	.20	.....	.15	.10	.20
29	.20	.....	.....	.20	.90	.70	.60	.15	.....	.20	.10	.20
30	.20	.....	.....	.20	1.50	.40	.80	.15	.....	.30	.15	.40
31	.20	.....	.....	.....	1.60	.....	.20	.20	.....	.20	.....	.40

ARKANSAS RIVER AT AMITY CANAL HEAD GATES, COLORADO.

This station is located at the head of Amity Canal, 7 miles west of Lamar, and is maintained by the Amity Canal Company, which keeps the records of the amount of water flowing into the ditch, over the dam, and out of the wasteway of the canal. The following figures of monthly flow were furnished through the courtesy of C. W. Beach, hydrographer for the company, and represent the total flow at this point. A measurement was made by J. E. Field at Lamar, June 9, 1901, giving a discharge of 997 second-feet.

Monthly discharge, in second-feet, of Arkansas River at Amity Canal head gates, Colorado, for 1901.

Month.	Discharge.	Month.	Discharge.	Month.	Discharge.
	Sec.-ft.		*Sec.-ft.*		*Sec.-ft.*
January	224	June	1,944	November	175
February	401	July	197	December	172
March	51	August	485		
April	145	September	282	Mean	451
May	1,270	October	64		

ARKANSAS RIVER NEAR GRANADA, COLO.

This station, established July 24, 1898, is located at the head gates of the Buffalo Creek Canal, 2 miles northeast of Granada. Since the establishment of the station readings have been made throughout the irrigation seasons (1898, 1899, 1900, and 1901) by Ben Riley, head-gate keeper of the Buffalo Canal. No measurements have been made at this point, and no rating table has been computed. A brief description of the station, with gage heights for 1900, was published in Water-Supply Paper No. 50, page 329.

Daily gage height, in feet, of Arkansas River near Granada, Colo., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.50	3.50	2.00	1.20	1.80	4.80	2.00	1.80	2.00	1.00	1.00	1.00
2	2.60	3.50	1.80	1.20	1.70	5.00	2.00	1.60	2.00	1.00	1.00	1.00
3	2.60	3.50	3.00	1.20	1.70	4.00	1.80	1.60	1.80	1.00	1.00	1.00
4	2.60	3.50	3.00	1.20	1.80	4.00	1.80	1.60	1.60	1.00	1.00	1.20
5	2.60	3.60	3.00	1.00	1.70	3.80	1.60	1.60	1.50	1.00	1.00	1.20
6	2.60	3.60	2.40	1.00	1.70	3.60	1.60	1.40	1.20	1.00	1.00	1.20
7	2.60	3.80	2.00	1.20	1.70	3.40	1.60	1.40	1.20	1.00	1.00	1.20
8	2.80	3.60	2.00	1.20	1.70	3.00	1.40	1.20	1.00	1.00	1.00	1.20
9	2.80	3.60	1.80	1.40	1.50	3.00	1.40	1.80	1.00	1.00	1.00	1.20
10	2.80	3.60	1.60	1.40	1.70	3.00	1.20	3.80	1.00	1.00	1.00	1.20
11	3.00	3.60	1.00	1.60	1.70	2.80	1.20	3.40	1.00	1.00	1.00	1.20
12	3.00	3.50	1.00	1.50	1.70	2.80	1.20	3.60	1.00	1.00	1.00	1.20
13	3.50	3.50	1.00	1.20	1.70	2.60	1.20	3.20	1.00	1.00	1.00	1.20
14	3.50	3.60	1.00	1.20	1.70	2.40	1.20	3.00	1.00	1.00	1.00	1.20
15	3.50	3.80	1.00	1.40	1.80	2.00	1.20	2.00	1.20	1.00	1.00	1.20
16	3.50	3.80	1.00	1.40	2.80	3.00	1.20	2.00	1.20	1.00	1.00	1.20
17	3.50	3.80	1.40	1.40	2.80	3.60	1.40	2.40	1.00	1.00	1.00	1.40
18	3.50	3.60	1.00	1.20	2.40	3.60	1.40	1.80	1.00	1.00	1.00	1.40
19	3.50	3.60	1.00	1.20	2.00	3.40	1.40	1.80	.90	1.00	1.00	1.40
20	3.50	3.40	1.00	1.20	1.80	3.20	1.40	2.40	.90	1.00	1.00	1.40
21	3.50	3.40	1.00	1.20	1.80	3.00	1.50	2.00	.90	1.00	1.00	1.50
22	3.50	3.40	1.00	1.60	1.80	3.00	1.50	1.80	.90	1.00	1.00	1.50
23	3.50	3.20	1.00	1.40	3.20	2.80	1.50	1.60	.90	1.00	1.00	1.60
24	3.50	3.00	1.00	1.40	3.00	2.50	1.60	2.00	.90	1.00	1.00	1.60
25	3.50	3.00	1.00	1.40	2.60	2.40	1.60	1.80	.90	1.00	1.00	1.60
26	3.50	3.00	1.00	1.60	2.70	2.00	1.70	1.60	1.00	1.00	1.00	1.60
27	3.40	2.40	1.00	1.60	3.70	1.60	1.60	1.40	1.00	1.00	1.00	1.60
28	3.40	2.00	1.00	1.60	3.40	1.80	2.80	1.40	1.00	1.00	1.00	1.60
29	3.40	.....	1.00	1.60	3.40	2.00	2.60	1.20	1.00	1.00	1.00	1.60
30	3.40	.....	1.00	1.80	3.40	2.00	2.80	1.00	1.00	1.00	1.00	1.60
31	3.40	.....	1.00	.....	5.00	.....	2.40	1.00	.....	1.00	.....	1.60

ARKANSAS RIVER NEAR BARTON, COLO.

This station was established May 2, 1901, at the railroad bridge one-half mile east of Barton or Byron, which is the name of the railroad station on the Atchison, Topeka and Santa Fe Railway. Throughout this region the bed of the stream is broad and sandy, the channel

being shifting. This point was selected as the most available place for determining approximately the discharge of the Arkansas at a point near the Colorado-Kansas line. The rod consists of a vertical 2 by 4 inch piece of timber 7 feet long, nailed to a pile on the downstream side of the railroad bridge at the last point in the channel. No bench mark was established, but the rod was spiked at the foot marks to the pile. The channel is extremely shifting, and there may be at times many different channels. The initial point for soundings is the right bank. The observer is Harry Hunt, postmaster at Barton. Only two gagings were made in 1901, and at the first of these, when the station was established, no water was passing. The second measurement, made June 10 by J. E. Field, yielded a discharge of 1,911 second-feet at a gage height of 1.60 feet.

Daily gage height, in feet, of Arkansas River near Barton, Colo., for 1901.

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1		2.35	0.40	1.00	0.50	0.20	0.15	0.50
2		3.00	.30	.80	1.80	.20	.15	.55
3		3.80	.20	.40	1.90	.20	.15	.60
4		3.20	1.40	.30	2.00	.10	.15	.60
5		2.90	1.50	.10	2.00	.10	.15	.60
6		2.10	1.10	.10	1.80	.20	.15	.65
7		1.80	.80	.10	1.80	.20	.15	.65
8		1.75	.70	.00	1.70	.20	.20	.70
9		1.60	.50	1.80	1.70	.25	.20	.70
10		1.60	.40	1.60	1.60	.25	.20	.65
11		1.50	.30	1.20	1.50	.30	.20	.65
12	0.00	1.40	.10	1.00	1.20	.20	.15	.70
13	.00	1.50	.00	.90	.90	.20	.10	.80
14	.00	1.60	.00	.50	.70	.20	.10	.80
15	.00	1.60	.00	.30	.50	.20	.10	.85
16	1.30	1.60	.00	.20	.50	.20	.10	.85
17	.95	1.60	.00	.10	.40	.30	.10	.85
18	.70	1.55	.00	.30	.40	.30	.10	.85
19	.30	1.50	.00	.30	.40	.30	.10	.90
20	.20	1.50	.00	.40	.30	.35	.15	.90
21	.10	1.40	.00	.40	,30	.20	.20	.90
22	.10	1.20	.00	.40	.30	.20	.30	1.00
23	.60	1.00	.00	.30	.30	.20	.35	1.00
24	1.50	.90	.00	.30	.30	.20	.35	1.00
25	1.80	.90	.00	.30	.20	.20	.40	1.00
26	1.90	.90	1.60	.20	.20	.20	.40	1.00
27	1.70	.80	1.80	.30	.20	.20	.60	1.05
28	1.80	.80	1.60	.30	.30	.20	.50	1.05
29	1.50	.60	1.50	.40	.40	.10	.50	1.05
30	3.00	.60	1.40	.40	.20	.10	.50	1.10
31	2.65		1.30	.40		.15		1.10

MISCELLANEOUS DISCHARGE MEASUREMENTS IN MISSISSIPPI RIVER BASIN IN COLORADO.

Date.	Stream.	Locality.	Hydrographer.	Gage height.	Discharge.
				Feet.	*Sec.-ft.*
May 14	Cache la Poudre River.	Greeley	J. E. Field		50
May 6	Lake Creek	Interlaken	do	0.50	113
May 11	do	do	C. W. Beach	.67	99
May 6	do	Lower Twin Lakes	J. E. Field	2.00	120
May 7	do	do	do	1.10	42
Do	do	do	do	1.70	87
Apr. 12	Cimarron River	Cimarron	A. L. Fellows		38
May 18	do	do	do		814

ARKANSAS RIVER AT HUTCHINSON, KANS.

This station was established May 13, 1895. It is described in Water-Supply Paper No. 50, page 330. Results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 344.

The following discharge measurements were made during 1901 by W. G. Russell:

May 23: Gage height, 1.50 feet; discharge, 134 second-feet.
August 14: Gage height, 0.95 foot; discharge, 33 second-feet.
October 16: Gage height, 1.25 feet; discharge, 72 second-feet.

Daily gage height, in feet, of Arkansas River at Hutchinson, Kans., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.20	1.25	2.00	1.50	1.70	1.30	1.75	0.95	0.75	1.10	1.05	0.95
2	([a])	1.25	2.00	1.60	1.70	1.30	1.65	.90	.75	1.10	1.00	.95
3	1.20	1.25	2.00	1.70	1.70	1.30	1.55	.90	.75	1.10	1.00	.95
4	([a])	1.25	1.90	1.70	1.65	1.30	1.50	.90	.75	1.10	1.00	.95
5	1.20	1.25	1.85	1.85	1.65	1.60	1.45	.90	.75	1.10	1.00	.95
6	([a])	1.25	1.80	1.85	1.60	1.40	1.45	.90	.75	1.00	1.00	.95
7	1.20	1.25	1.75	2.00	1.60	3.80	1.40	.85	.75	1.00	1.00	.95
8	1.20	1.25	1.70	2.20	1.55	3.50	1.35	.85	1.00	1.00	.95	.95
9	1.20	1.25	1.65	2.20	1.55	3.50	1.30	.80	.95	1.00	.95	.95
10	.....	1.25	1.65	2.80	1.55	3.40	1.25	.80	.95	1.50	.95	.95
11	1.20	1.25	1.60	2.70	1.50	3.30	1.20	1.10	.90	1.50	.95	.95
12	1.20	1.20	1.50	2.70	1.50	3.10	1.15	.90	.85	1.50	.95	1.00
13	1.30	1.25	1.50	2.60	1.50	3.00	1.10	.85	.85	1.50	.95	1.00
14	1.30	1.30	1.50	2.50	1.50	2.80	1.05	.95	1.75	1.50	.95	1.00
15	1.40	1.35	1.50	2.40	1.50	2.60	1.05	.90	1.70	1.40	.95	1.00
16	1.50	1.45	1.50	2.40	1.50	2.60	1.05	.90	1.60	1.30	.95	.....
17	1.50	1.50	1.50	2.30	1.50	2.50	1.05	.90	1.45	1.25	.95	1.00
18	1.45	1.70	1.50	2.20	1.50	2.45	1.20	.85	1.30	1.20	.95	.....
19	1.40	1.90	1.50	2.00	1.50	2.55	1.15	.85	1.30	1.15	.95	1.00
20	1.30	1.90	1.50	2.00	1.50	2.30	1.10	.85	1.30	1.10	.95	.....
21	1.30	1.90	1.50	2.00	1.50	2.25	1.10	.85	1.20	1.10	.95	1.00
22	1.25	2.40	1.50	2.00	1.50	2.15	1.10	.80	1.10	1.10	.95	1.00
23	1.25	2.10	1.50	2.00	1.50	2.50	1.15	.80	1.10	1.05	.95	1.00
24	1.25	1.85	1.50	2.00	1.45	2.45	1.15	.80	1.10	1.05	.95	1.00
25	1.25	1.85	1.50	1.90	1.45	2.25	1.10	.75	1.10	1.05	.95	1.00
26	1.25	1.90	1.50	1.90	1.40	2.15	1.10	.75	1.10	1.10	.95	1.00
27	1.25	1.90	1.50	1.85	1.35	2.00	1.10	.75	1.05	1.00	.95	1.00
28	1.25	1.95	1.50	1.80	1.35	1.95	.95	.75	1.05	1.20	.95	1.15
29	1.25	.....	1.50	1.75	1.35	1.85	.90	.75	1.00	1.20	.95	1.15
30	1.25	.....	1.50	1.70	1.30	1.80	1.05	.75	1.10	1.10	.95	1.15
31	1.25	.....	1.50	.....	1.30	.....	1.00	.75	.....	1.05	.....	1.15

[a] Ice.

VERDIGRIS RIVER NEAR LIBERTY, KANS.

This station, which was originally established in August, 1895, is described in Water-Supply Paper No. 50, page 330. Results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 345. During 1901 the following discharge measurements were made by W. G. Russell:

May 22: Gage height, 3.30 feet; discharge, 573 second-feet.
August 13: Gage height, 1.90 feet; discharge, 78 second-feet.
October 12: Gage height, 1.80 feet; discharge, 53 second-feet.

Daily gage height, in feet, of Verdigris River near Liberty, Kans., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.90	3.00	3.20	3.80	4.20	2.20	2.15	2.50	1.20	2.10	1.90	1.90
2	2.90	3.00	3.20	6.75	3.80	2.10	1.95	2.25	1.20	2.00	1.90	1.90
3	2.90	3.20	3.20	5.75	3.65	2.10	1.90	2.10	1.20	1.90	1.90	1.90
4	2.90	6.20	3.20	5.65	3.65	2.10	1.80	2.25	1.20	1.90	1.90	1.90
5	2.90	5.10	3.10	5.55	6.45	2.10	1.75	2.15	1.30	2.05	1.90	1.90
6	2.90	4.20	3.10	5.80	4.35	2.10	1.70	2.00	1.30	2.00	1.90	1.90
7	2.80	3.90	3.10	7.90	3.65	2.10	1.70	1.90	1.30	2.00	1.90	1.90
8	2.80	3.80	3.00	8.30	3.45	2.10	1.70	1.75	1.30	2.00	1.90	1.90
9	2.80	3.80	3.00	5.25	3.30	2.00	1.60	1.70	1.30	1.90	1.90	2.00
10	2.80	3.90	8.70	5.45	3.20	2.00	1.60	1.60	1.30	1.90	1.90	2.00
11	3.40	3.80	13.00	14.60	3.05	1.90	1.60	1.70	1.30	2.00	1.90	2.00
12	3.40	3.80	5.70	16.25	2.90	1.90	1.60	1.80	1.30	2.20	1.90	2.00
13	3.30	3.50	4.80	20.40	2.90	1.90	1.60	1.90	1.20	2.20	1.90	2.00
14	3.30	3.40	4.00	18.30	2.90	1.90	1.50	1.80	2.90	2.20	1.80	2.00
15	3.40	3.20	3.70	14.35	2.90	1.90	1.50	1.80	5.40	2.10	1.80	2.00
16	4.00	4.00	3.60	7.95	2.80	1.90	1.40	1.80	4.15	2.10	1.80	2.00
17	4.00	5.00	3.50	6.40	3.85	1.90	1.40	1.80	3.10	2.00	1.80	2.00
18	3.80	6.10	3.50	5.85	4.65	1.90	1.40	1.70	2.75	2.00	1.80	2.00
19	3.60	5.40	3.60	5.50	3.85	1.90	1.40	1.70	2.45	2.00	1.80	2.00
20	3.40	5.00	3.80	5.25	3.70	2.00	1.40	1.60	2.30	2.00	1.80	2.00
21	3.30	4.70	4.00	4.95	3.60	1.90	1.40	1.50	2.30	2.00	1.80	2.00
22	3.30	4.40	4.40	4.80	3.30	3.90	1.30	1.50	2.20	2.00	1.90	2.00
23	3.30	4.10	3.90	4.65	3.15	2.95	1.30	1.40	2.10	2.00	1.90	2.00
24	3.20	3.80	3.60	4.45	3.05	2.85	1.30	1.40	2.05	2.00	1.90	2.00
25	3.20	3.60	3.50	4.40	3.00	2.80	1.30	1.30	1.90	1.90	1.90	2.00
26	3.20	3.40	3.40	4.30	2.90	2.70	1.30	1.30	2.00	1.90	1.90	2.00
27	3.10	3.30	3.35	4.00	2.80	2.55	1.30	1.30	2.00	1.90	1.90	2.00
28	3.10	3.30	3.20	3.95	2.65	2.40	1.30	1.30	2.00	1.90	1.90	2.00
29	3.10	.....	3.50	3.85	2.30	2.30	1.40	1.30	2.00	1.90	1.90	2.00
30	3.10	.....	4.20	4.30	2.20	2.30	1.55	1.30	2.30	1.90	1.90	2.00
31	3.00	.....	3.80	.....	2.20	.....	1.60	1.20	.....	1.90	.....	2.00

NEOSHO RIVER NEAR IOLA, KANS.

This station, which was established in July, 1895, is described in Water-Supply Paper No. 50, page 331. Records of discharge measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, pages 346. During 1901 the following discharge measurements were made by W. G. Russell:

April 4: Gage height, 5.20 feet; discharge, 3,206 second-feet.
May 22: Gage height, 3.60 feet; discharge, 917 second-feet.
August 13: Gage height, 2 feet; discharge, 190 second-feet.
October 11: Gage height, 2 feet; discharge, 190 second-feet.

Daily gage height, in feet, of Neosho River near Iola, Kans., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.50	2.70	3.60	3.90	4.00	3.10	2.50	2.00	1.60	0.90	0.50	0.60
2	2.50	2.70	3.55	4.60	4.00	3.00	2.50	2.00	1.60	.90	.50	.60
3	2.60	2.60	3.50	5.05	3.80	3.00	2.40	2.00	1.50	.90	.50	.60
4	2.60	2.60	3.40	5.40	3.80	3.00	2.40	2.00	1.50	.90	.50	.60
5	2.60	2.60	3.30	5.80	3.70	3.00	2.40	1.90	1.50	.90	.50	.60
6	2.60	2.50	3.25	8.75	3.70	3.00	2.35	1.90	1.50	.90	.60	.60
7	2.50	2.50	3.20	11.00	3.70	3.00	2.30	1.90	1.50	.90	.70	.60
8	2.50	2.55	3.25	12.00	3.70	3.00	2.30	2.00	1.40	.90	.70	.70
9	2.50	2.60	3.35	9.50	3.70	3.00	2.30	2.00	1.40	.90	.70	.70
10	2.80	2.60	3.80	5.35	3.70	3.25	2.30	2.00	1.40	.90	.70	.70
11	2.80	2.60	4.15	4.90	3.70	5.65	2.30	2.00	1.30	.90	.70	.70
12	2.80	2.70	3.75	7.15	3.60	4.90	2.20	2.00	1.30	.90	.70	.70
13	2.80	2.90	3.55	10.90	3.60	3.90	2.35	2.00	1.30	.90	.70	.70
14	2.80	3.50	3.35	12.10	3.60	3.60	2.30	2.00	1.40	.90	1.00	.70
15	3.50	3.80	3.05	12.60	3.60	3.40	2.30	2.00	1.30	.90	1.00	.70
16	3.30	4.25	3.00	12.90	3.60	3.00	2.30	2.00	1.30	.50	.90	.60
17	3.00	4.55	3.00	13.30	3.50	3.00	2.30	2.00	1.30	.50	.90	.60
18	2.85	4.60	2.90	11.80	3.50	2.95	2.20	2.00	1.30	.50	.80	.50
19	2.80	4.95	3.30	6.25	3.50	3.00	2.20	1.90	1.30	.50	.80	.50
20	2.70	5.25	3.65	5.20	3.50	3.10	2.20	1.90	1.20	.50	.80	.50
21	2.70	4.80	3.90	5.20	3.60	3.30	2.20	1.90	1.20	.50	.80	.50
22	2.70	4.60	3.60	4.70	3.60	4.00	2.20	1.90	1.00	.50	.60	.50
23	2.60	4.00	3.30	4.60	3.60	3.50	2.10	1.80	1.00	.50	.60	.60
24	2.60	4.00	3.30	4.50	3.50	3.40	2.15	1.80	1.00	.50	.60	.60
25	2.70	4.00	3.30	4.25	3.50	3.10	2.00	1.80	1.00	.50	.60	.60
26	2.70	4.00	3.65	4.20	3.50	3.00	2.00	1.70	1.00	.50	.60	.90
27	2.60	3.80	3.95	4.20	3.40	2.95	2.00	1.70	1.00	.50	.60	1.15
28	2.60	3.80	3.80	4.20	3.35	2.85	2.00	1.70	1.00	.50	.60	1.20
29	2.60	.....	3.80	4.20	3.20	2.70	2.00	1.70	.90	.50	.60	1.20
30	2.60	.....	3.90	4.10	3.10	2.70	2.00	1.70	.90	.50	.60	1.00
31	2.70	.....	3.70	.....	3.10	.....	2.00	1.70	.....	.50	.....	1.00

WESTERN GULF DRAINAGE.

While the year 1900 was an exceedingly wet one throughout Texas, the year 1901 was as dry as usually falls to the lot of that State. During the early part of 1901 the rivers showed in their flow a relatively large run-off derived from the high precipitation of the preceding year, but before the summer had waned evaporation and lack of rain had reduced the flow of all the streams of the State considerably and in the fall some reached the lowest known stages on record. Following is a description of a number of rivers in Texas visited during December, 1901, by Prof. T. U. Taylor, of the University of Texas at Austin, Tex. Measurements were made by him also of San Felipe Springs, near the town of Del Rio, the flow on December 16 being 150 second-feet; of Barton Springs, at Austin, the flow December 23 being 28 second-feet; and of the Hot Wells at San Antonio, the flow on December 31 being 41 second-feet. A description of these springs will be found in Water-Supply Paper No. 50.

BRAZOS RIVER AT WACO, TEX.

This station, which was established September, 1898 by T. U. Taylor, is described in Water-Supply Paper No. 50, page 333.

In the latter part of December, 1901, the river reached the lowest flow of its recorded history, a measurement made December 28 giving a discharge of 69 second-feet. The bed of the river has been modified

materially during the past year, the deepest part of the channel being no longer adjacent to the southwest bank, but at present about 50 feet from the gage. The following measurements of discharge were made by T. U. Taylor and C. N. Campbell during 1901:

List of discharge measurements of Brazos River at Waco, Tex.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1901.	*Feet.*	*Sec.-ft.*	1901.	*Feet.*	*Sec.-ft.*
January 1	3.15	3.85	November 12	2.30	0.76
March 9	2.85	2.68	November 28	3.00	2.42
May 11	2.40	1.30	December 21	2.50	.98
October 15	3.48	5.83	December 26	2.38	.73
November 2	2.40	.87	December 27	2.35	.70
November 12	2.30	.77	December 28	2.32	.69

Daily gage height, in feet, of Brazos River at Waco, Tex., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.20	2.80	3.00	2.90	2.80	6.60	2.75	2.35	3.30	2.90	2.40	2.90
2	3.20	2.80	3.00	2.80	2.80	6.95	2.70	2.25	2.95	2.85	2.40	2.80
3	3.20	2.80	2.90	2.70	2.80	11.40	2.65	4.30	2.80	2.75	3.45	2.75
4	3.20	2.80	2.90	4.30	2.80	8.90	2.60	4.40	2.60	2.70	2.85	2.70
5	3.15	2.90	2.90	4.35	2.70	8.65	2.50	4.10	2.20	2.60	2.80	2.70
6	3.10	2.90	2.85	4.45	2.70	9.05	2.50	4.10	2.40	2.60	2.60	2.70
7	3.10	3.00	2.75	4.20	2.60	7.95	2.40	3.95	2.70	2.60	2.55	2.70
8	3.10	3.10	2.70	4.00	2.60	6.95	2.40	3.70	2.60	2.45	2.50	2.80
9	3.10	3.10	2.80	3.80	2.60	6.45	2.40	3.50	2.50	2.40	2.45	2.70
10	3.10	3.10	2.80	3.60	2.50	5.80	2.30	3.40	2.40	2.40	2.30	2.55
11	3.10	3.20	2.80	3.55	2.40	5.40	2.30	3.25	2.30	3.15	2.30	2.50
12	3.10	3.40	2.80	3.50	2.40	5.10	2.30	3.15	2.25	3.50	2.30	2.50
13	3.10	3.60	2.75	3.80	2.40	5.10	2.30	3.10	3.10	3.25	2.30	2.50
14	3.10	3.55	2.70	3.50	2.40	4.75	2.30	3.75	5.20	3.05	2.30	2.50
15	3.10	3.45	2.70	3.30	2.30	4.45	2.25	3.80	6.00	2.90	3.00	2.50
16	3.10	3.30	2.70	3.20	2.30	4.30	2.20	3.15	4.70	3.40	3.85	2.50
17	3.10	3.25	2.60	3.45	7.25	4.05	2.20	3.10	4.55	3.30	3.75	2.50
18	3.10	3.20	2.70	3.30	10.00	3.90	2.20	3.05	4.50	3.35	3.70	2.50
19	3.00	3.20	2.80	3.25	14.75	3.75	2.20	2.90	4.40	3.20	3.55	2.60
20	3.00	3.25	2.70	3.20	10.50	3.65	2.10	2.80	4.30	3.00	3.40	2.60
21	3.00	3.30	2.70	3.10	8.15	3.50	2.20	2.70	4.60	3.05	3.30	2.50
22	3.00	3.30	2.70	3.10	7.70	3.45	2.55	2.65	4.20	2.80	3.30	2.50
23	3.00	3.30	2.80	3.70	7.30	3.40	2.25	2.60	3.85	2.70	3.20	2.50
24	3.00	3.20	2.70	3.85	6.90	3.20	2.20	2.60	3.65	2.70	3.10	2.50
25	3.00	3.20	2.70	3.65	6.25	3.15	2.20	2.55	3.50	2.60	3.00	2.45
26	3.00	3.10	2.70	3.30	6.00	3.00	2.75	2.40	3.35	2.60	3.00	2.40
27	2.95	3.10	2.70	3.10	5.60	3.05	2.90	2.65	3.20	2.60	2.90	2.35
28	2.90	3.10	2.70	3.10	5.45	3.05	2.85	3.50	3.20	2.50	3.00	2.30
29	2.90	.....	2.70	2.95	5.30	2.90	2.55	3.15	3.10	2.50	2.95	2.30
30	2.90	.....	3.80	2.90	5.25	2.80	2.35	3.00	3.10	2.50	2.90	2.30
31	2.90	.....	3.20	.....	5.85	.....	2.20	2.80	.....	2.40	.....	2.30

BOSQUE RIVER, TEXAS.

Bosque River rises in Erath County and after traversing Bosque County flows into Brazos River 4 miles west of Waco. It is a stream of high banks, and has a perennial flow, which, however, at low stages is not sufficient for irrigation or for continuous power purposes. The water is clear and the bed rocky and gravelly at the section used for measurement. The flow was measured on December 26, 1901, at the iron bridge 5 miles west of Waco and gave a discharge of 3 second-feet. There is a power plant on this river at Clifton, Bosque County.

SULPHUR FORK OF LAMPASAS RIVER, TEXAS.

This fork rises in the town of Lampasas, in the Hancock and Hanna springs, fully described in Water-Supply Paper No. 50, page 335. The flow was measured in December, 1900, and gave a discharge of 10 second-feet. The flow was again measured on December 19, 1901, by Thomas U. Taylor, and gave a discharge of 11 second-feet. The Sulphur Fork flows into the main Lampasas near the town of Kempner, and at low stages carries more water than the main branch. The Lampasas, the Solado, and the Leon unite southeast of Belton at a point known as Three Rivers, to form Little River.

SOLADO RIVER, TEXAS.

The Solado River has its source in the famous Solado Springs, in the town of Solado, 9 miles south of Belton. These are similar in source, behavior, and character of water to those of San Marcos, San Antonio, Del Rio, etc. Formerly two dams existed across the Solado, one in the town and the other some distance below. The flow was measured on December 19, 1901, by Thomas U. Taylor, and a discharge of 13 second-feet was found. The stream below the town is often rather deep, and resembles in all its characteristics the San Marcos. The bed is rocky, and the reliable flow would make the stream available for power purposes.

Two flour mills and 2 cotton gins are at present in active operation on the Solado. Summer's mill, 2 miles above the mouth, derives its power by means of a 10-foot stone dam. Six miles above this mill is located Stinnett's flour mill, where a head of 18 feet is obtained with a race 1 mile long and a dam 3 feet high. Between these two plants are located the cotton gins referred to.

LEON RIVER, TEXAS.

The Leon was described fully in Water-Supply Paper No. 50, page 334. It unites with the Nolan in the suburbs of Belton. The year 1901 was conspicuous for low water in the Leon, the flow being sufficient to run the power plant 1 mile east of Belton only. On December 20, 1901, the water in the lake above the dam was about 1 foot below the crest, but water was leaking through the dam and mill race. The flow was found to be only 6 second-feet. The Nolan River was measured just west of town and a discharge of only 1 second-foot was found.

LITTLE RIVER, TEXAS.

The Little River is formed by the Leon, Lampasas, and Solado. It has high banks, and for most of its course is deep and clear and flows slowly. The valleys on each side are among the richest in Texas. The land rises very gradually from the banks, and the floods to which this stream is subject spread out over the bottom lands and at many places cover a width of 2 miles. The liability of the river to overflow

the bottom lands on each side has rendered its use for power purposes rather discouraging, as damage suits would inevitably follow an overflow. The flow was measured by Thomas U. Taylor, at McCowan's ford, 2 miles south of Cameron, on December 20, 1901, and gave a discharge of 59 second-feet. The stream at this place was 29 feet wide, with an average depth of 14 inches and a mean velocity of 1.72 feet per second. This measurement can be regarded as the lowest minimum at this section, as no rains had fallen on its watershed for several months, the season of 1901 having been an especially dry one in Texas.

CONCHO RIVER, TEXAS.

Concho River discharges into the Colorado in the southwest corner of Coleman County. The main Concho, from its junction with the Colorado to the point where it is formed by the North and Middle Conchos, 1½ miles east of San Angelo, is about 45 miles long in an air line. Above San Angelo the waters of the Conchos are utilized for irrigation in Sterling, Irion, and Tom Green counties. The North Concho traverses the counties of Andrews, Martin, Glasscock, Sterling, and Tom Green, and is subject to great freshets, that have flooded the streets of San Angelo. It has a reliable low-water flow, and at present furnishes water for three irrigation systems, two in Sterling County and one in Tom Green County. Another irrigation plant a few miles above San Angelo derived its water from the North Concho, but a flood swept away the dam, and it has never been rebuilt. The flow of the North Concho was measured by Thomas U. Taylor, December 17, 1901, at a point halfway between the highway bridge at San Angelo and the ford above. At this point the river has a very rough, irregular bottom, composed of a conglomerate rock. At low stage the stream is divided into many irregular channels. At the point of measurement the water was passing through a small and smooth pass only 7 feet wide and 9½ inches deep. The average velocity was found to be 1⅔ feet per second, giving a flow of 9⅓ second-feet. This was the lowest stage of the river, as there had been no effective rain for several months. The Middle Concho flows through west Tom Green, Irion, and east Tom Green counties. Its length is about half that of the north fork, but its low flow near San Angelo is about seven times greater. Affluent streams of importance are Spring Creek and the South Concho. These together supply water for ten irrigation systems. Three of these are at Sherwood, on Spring Creek; three near Knickerbocker, on Dove Creek, a tributary of Spring Creek; three near Christoval, on the South Concho, and one 4 miles south of San Angelo, below the junction of the South and Middle forks. The south branches are unfailing in their water supply, and there is sufficient water to double the area under irrigation. The stream is a succession of beautiful lakes or pools, connected by shoals, where the water flows over the rough segregated stone bottom. The river was measured by Mr. Taylor on December 17, 1901, just below the ford, 4 miles south of

San Angelo, and gave a discharge of 69 second-feet. This section was near the Cunningham dam, which supplies the irrigation system of that name.

MILL CREEK, TEXAS.

This small stream has its source in large springs in the suburbs of the town of San Saba. A stone dam has been constructed across the stream near its head and the backwater spreads over the supplying springs. The dam is a substantial stone structure repaired late in 1901. It supplies power to operate a mill, and pressure for the town water supply, and serves to raise the water into the irrigation ditch that leads to the land of Mr. Kirkpatrick. The flow was measured by Thomas U. Taylor on December 18, 1901, a short distance below the dam while water was flowing freely over the waste weir. The discharge was found to be 10 second-feet.

LLANO RIVER, TEXAS.

The Llano River rises in Sutton County, within a few miles of the headwaters of Devils River. It traverses Sutton, Kimble, and Mason counties and enters Colorado River at Kingsland, in the eastern part of Llano County. In its upper part, notably in Kimble County, it is a very effective irrigation stream as there are no less than 30 independent systems that draw their waters from it and its tributaries. Below Kimble County no attempt has been made to utilize the water for irrigation purposes, but three power plants are located upon it, near the town of Llano. J. K. Finlay owns two plants 2 and 8 miles above Llano, while at the town there is a small but very effective plant that operates the pumps of the city waterworks and the electric-light plant. The Llano was measured by Thomas U. Taylor in March, 1899, and gave a discharge of 76 second-feet. It was again measured on November 9, 1901, and gave a discharge of 105 second-feet. The river was said to be at its lowest stages during both measurements. Assuming the lowest measurement (76 second-feet), the present dam with its fall of 9 feet can develop 57 horsepower continuously, or 160 horsepower if used only sixty hours during the week and its flow conserved the rest of the time.

GUADALUPE RIVER, TEXAS.

The Guadalupe with its tributaries furnishes power for no less than 17 plants. Two of these are above New Braunfels, in Kerr County, two on the Comal River, three at Luling, eight on San Marcos River, and two below the mouth of the San Marcos. The flow of the Comal was fully treated in Water-Supply Paper No. 50. The Guadalupe was measured in March, 1901, on the crest of the dam of the Berchel Power Company, 3 miles north of Cuero, and the discharge was found to be 551 second-feet. The crest of the dam is flat, 6 feet broad and 140 feet long between bulkheads. The water was 1.15 feet deep on the

crest and had an average velocity of 3.42 feet per second. The measurement was made by wading on the crest. There had been no rain on the watershed of the river for months and it was down to a low stage, as reported by the engineer of the power plant.

CARRIZO SPRINGS, TEXAS.

Carrizo Springs Creek flows through the village of Carrizo Springs one-fourth mile east of the court-house. It rises 5 miles southwest of the court-house, flows eastwardly, and empties into Nueces River at a point about 1 mile above the Carrizo Springs and Cotulla road crossing, or about 3 miles above Taylor's dam. The creek does not flow from one large spring, but is the accumulated flow of a number of small springs scattered along its length. A measurement made by E. C. H. Bantel, on December 30, 1901, at low water, showed the flow to be 1.32 second-feet.

An abundant supply of water may be obtained anywhere in this section by digging or drilling wells. In the former the water is found at from 10 to 15 feet below the surface. Drilled wells 90 feet deep give a small but steady flow, and as the depth increases the flow becomes greater. There are seven or eight artesian wells scattered in the section north of the town. One of these, known as Campbell's well, has a 5-inch pipe sunk 350 feet, and flows about 50 gallons per minute. The water is used to irrigate several acres of land on which garden truck is raised. The owner of the well has installed a 15-horsepower gasoline engine and a 5-inch centrifugal pump to augment his supply of water and has constructed two earthen tanks or reservoirs having a total area of about 2 acres and a depth of 8 feet.

Another artesian well, known as the Paterson well, has recently been completed at a point about 5 miles southeast of the court-house. This well has a 5⅝-inch pipe, is 590 feet deep, and flows about 200 gallons per minute. Its flow for the three months October, November, and December, 1901, was constant.

About one-half mile south of the court-house is the dug well from which the Carrizo mineral water is obtained. The well is said to be 60 feet deep; the water rises to a point 25 feet from the surface, and is pumped out by an ordinary hand pump. The analysis of this mineral water is as follows:

Analysis of Carrizo Springs mineral water.

	Gr. U. S. G.
Total mineral matter	1,306.18
Magnesium sulphate	231.00
Sodium sulphate	390.00
Sodium chloride	467.00
Sodium bicarbonate	80.30
Calcium	130.40
Potassium chloride	5.50
Soluble silica	.71

COLORADO RIVER AT AUSTIN, TEX.

Since the destruction of the dam, measurements have been made at the station about a fourth of a mile above the highway bridge on Congress avenue. The station is described in Water-Supply Paper No. 50, page 336. A full discussion of the flow of the river and the failure of the masonry dam on April 7, 1900, will be found in Water-Supply Paper No. 40. During the year 1901 the Colorado River was low, though the record does not exhibit the extreme low stage reached by the other Texas streams during the fall of 1901. It reached its lowest stage in July. The section between the bridge and the International and Great Northern Railroad bridge below was materially changed during the fall by the scouring out of its central portion and the formation of a gravel bar on the north side.

The following measurements were made by T. U. Taylor and C. N. Campbell during 1901:

List of discharge measurements of Colorado River at Austin, Tex.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1901.	*Feet.*	*Sec.-ft.*	1901.	*Feet.*	*Sec.-ft.*
June 24	1.80	2.99	November 13	2.55	8.98
July 6	1.60	2.18	November 18	2.25	7.32
October 23	1.85	4.24	November 23	2.10	5.82
October 28	1.80	4.17	December 6	1.90	4.42
October 31	1.80	4.25			

Daily gage height, in feet, of Colorado River at Austin, Tex., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.80	2.70	2.60	2.55	2.40	3.00	1.70	2.30	2.00	2.20	1.80	1.90
2	2.80	2.70	2.60	2.60	2.40	3.05	1.60	2.30	1.95	2.10	1.80	1.90
3	2.80	2.70	2.60	2.50	2.30	3.90	1.60	2.20	1.85	2.00	1.80	1.90
4	2.80	2.70	2.60	2.40	2.30	3.50	1.60	2.20	1.60	1.90	1.80	1.90
5	2.80	2.70	2.60	2.35	2.30	3.20	1.60	2.25	1.60	1.85	1.70	1.90
6	2.80	2.70	2.60	2.30	2.30	2.95	1.50	2.60	1.80	1.85	2.75	1.90
7	2.80	2.70	2.60	2.30	2.30	2.75	1.50	2.40	1.90	1.80	4.45	1.90
8	2.80	2.70	2.50	2.30	2.30	2.95	1.50	2.30	1.80	1.75	4.20	1.90
9	2.80	2.70	2.50	2.30	2.30	2.95	1.50	2.25	1.70	1.70	3.50	1.90
10	2.80	2.70	2.50	2.30	2.30	2.75	1.55	2.15	1.75	1.70	3.20	1.90
11	2.80	2.70	2.50	2.40	2.65	3.10	1.65	2.10	1.90	1.85	2.85	1.90
12	2.80	2.70	2.50	2.40	2.85	2.90	2.56	2.10	1.85	2.00	2.65	2.00
13	2.80	2.70	2.50	2.40	2.70	2.70	10.20	1.95	1.80	1.95	2.45	2.00
14	2.80	2.70	2.50	2.40	2.60	2.55	5.95	1.90	6.85	1.90	2.40	2.00
15	2.80	2.70	2.45	2.40	2.55	2.45	4.20	1.85	5.75	1.80	2.35	2.10
16	2.80	2.70	2.40	2.30	2.55	2.35	3.95	1.80	5.90	1.80	2.30	2.10
17	2.80	2.70	2.40	2.30	2.50	2.30	3.50	1.80	6.15	1.70	2.30	2.00
18	2.80	2.70	2.40	2.40	3.15	2.20	4.80	1.80	6.65	1.70	2.25	2.00
19	2.80	2.70	2.40	2.45	3.00	2.15	4.10	1.70	4.05	1.70	2.20	1.90
20	2.80	2.70	2.40	2.60	2.65	2.10	3.60	1.70	3.40	1.70	2.20	1.85
21	2.75	2.70	2.40	2.80	3.45	2.05	3.35	1.85	3.05	1.70	2.15	1.80
22	2.70	2.70	2.40	2.80	3.35	1.95	3.10	1.90	2.95	1.80	2.10	1.80
23	2.70	2.70	2.50	2.70	3.60	1.95	3.30	1.80	2.75	1.85	2.10	1.85
24	2.70	2.70	2.40	2.70	3.75	1.85	2.85	1.55	2.70	1.90	2.05	1.85
25	2.70	2.70	2.40	2.60	3.60	1.80	2.95	1.50	2.95	1.80	2.00	1.85
26	2.70	2.70	2.40	2.60	3.40	1.80	2.65	1.40	3.10	1.80	2.00	1.85
27	2.70	2.60	2.40	2.55	3.35	1.80	2.55	1.40	2.60	1.80	2.00	1.85
28	2.70	2.60	2.40	2.50	3.85	1.80	2.45	1.30	2.50	1.80	1.90	1.85
29	2.70	.....	2.40	2.50	4.15	1.70	2.40	1.30	2.40	1.80	1.90	1.85
30	2.70	.....	2.45	2.50	3.50	1.70	2.40	1.40	2.30	1.80	1.90	1.85
31	2.70	.....	2.50	.....	3.30	.....	2.40	1.90	.....	1.80	.....	1.85

RIO GRANDE NEAR DEL NORTE, COLO.

This station is about 2 miles west of the town of Del Norte, above the main canal taking water from the Rio Grande. Continuous records have been kept here by J. S. Regan since the fall of 1889. A description of this station is given in Water-Supply Paper No. 50, page 347. Results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV., page 347. A measurement was made by A. L. Fellows September 10, 1901, when the discharge was 470 second-feet, the gage height being 1.75 feet.

Daily gage height, in feet, of Rio Grande near Del Norte, Colo., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1				1.56	3.84	3.62	2.50	1.64	1.94	1.40		
2		[a] 2.24	[b] 2.28								1.44	
3	([a])			1.48	3.46	3.42	2.42	1.52	1.76	1.40		
4												
5	2.32			1.46	3.02	3.34	2.24	1.66	2.30	1.38		
6												
7				1.54	2.96	3.52	2.10	1.80	1.94	1.44		1.40
8												
9		[a] 2.30	2.10	1.62	3.00	4.00	2.00	1.80	1.80	1.46	1.44	
10												
11				1.56	3.62	3.60	1.96	1.64	1.78	1.48		
12	[a] 2.24											
13				1.66	3.58	3.38	1.82	1.62	1.72	1.42		
14												1.48
15				1.90	3.84	3.10	1.76	1.54	1.64	1.42		
16		[a] 2.42	1.94								1.48	
17				1.76	3.64	2.78	1.68	1.60	1.56	1.40		
18												
19	[a] 2.18			2.08	4.58	3.02	1.64	1.76	1.52	1.38		
20												
21				2.20	5.16	3.00	1.60	2.00	1.52	1.36		1.62
22												
23		[a] 2.36	1.42	2.16	3.64	3.06	1.62	1.76	1.48	1.36	1.40	
24												
25				2.86	4.24	3.00	1.70	1.80	1.46	1.38		
26	[a] 2.34											
27				3.18	4.42	2.84	1.86	1.78	1.44	1.42		1.66
28												
29				3.14	4.28	2.62	1.74	1.72	1.46	1.42		
30			1.54								1.38	
31					3.94		1.68	1.90		1.44		1.70

[a] Ice. [b] River open in center; ice on both sides.

RIO GRANDE AT CENICERO, COLO.

This station is a short distance above the Colorado State line, at a point where the river is crossed by a wagon bridge. Gagings were begun July 28, 1899, since which time continuous records have been kept. The station is an extremely important one, giving, as it does, the discharge of the river at the Colorado State line, including practically all of the Colorado drainage. A description of this station was published in Water-Supply Paper No. 50, page 348. The results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 349. During 1901 a measurement was made by A. L. Fellows on September 9, when the discharge was found to be 87 second-feet for a gage height of 1.20 feet.

Daily gage height, in feet, of Rio Grande at Cenicero, Colo., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.00	2.00	1.90	1.30	2.70	3.40	1.60	1.40	1.10	1.10	1.10	1.40
2	2.00	2.00	2.10	1.30	3.40	3.00	1.60	1.00	1.10	1.10	1.00	1.40
3	2.00	2.00	2.10	1.40	3.60	3.00	1.50	.90	1.10	1.10	1.00	1.50
4	2.00	2.00	2.20	1.40	3.30	2.90	1.50	.90	1.00	1.10	1.00	1.50
5	2.00	2.00	2.20	1.50	2.80	2.90	1.40	.90	1.00	1.10	1.00	1.50
6	2.00	2.00	2.10	1.50	2.70	2.90	1.40	1.10	1.00	1.10	1.00	1.60
7	2.00	2.00	2.10	1.50	2.70	2.80	1.30	1.10	1.00	1.10	1.00	1.60
8	2.00	2.00	2.00	1.50	2.70	3.00	1.30	1.20	1.00	1.10	1.00	1.60
9	2.00	2.00	1.90	1.40	2.70	3.20	1.30	1.20	1.00	1.10	1.00	1.60
10	2.00	2.00	1.90	1.40	2.70	3.20	1.20	1.20	1.10	1.10	1.00	1.70
11	2.00	2.00	1.80	1.30	2.70	3.00	1.20	1.20	1.10	1.10	1.00	1.70
12	2.00	2.00	1.70	1.30	2.80	3.00	1.20	1.20	1.10	1.10	1.00	1.70
13	2.00	2.00	1.70	1.30	2.90	2.70	1.20	1.10	1.10	1.10	1.00	1.70
14	2.00	2.00	1.70	1.30	3.10	2.60	1.20	1.10	1.10	1.00	1.00	1.70
15	2.00	2.00	1.60	1.30	3.10	2.60	1.20	1.10	1.10	1.00	1.00	1.80
16	2.00	2.00	1.60	1.30	3.10	2.50	1.20	1.10	1.10	1.00	1.00	1.80
17	2.00	2.00	1.60	1.30	3.10	2.50	1.20	1.10	1.00	1.00	1.00	1.80
18	2.00	2.00	1.60	1.30	2.90	2.30	.90	1.10	1.00	1.00	1.10	1.80
19	2.00	2.00	1.60	1.30	2.90	2.00	.90	1.10	1.00	1.00	1.10	1.80
20	2.00	2.00	1.60	1.30	3.00	2.00	.80	1.10	1.00	1.00	1.10	1.80
21	2.00	2.00	1.70	1.30	3.60	2.00	.80	1.10	1.00	1.00	1.20	1.80
22	2.00	2.00	1.70	1.40	4.00	2.00	.80	1.00	1.00	1.00	1.20	1.80
23	2.00	2.00	1.70	1.50	4.30	2.00	.80	1.00	1.10	1.00	1.30	1.80
24	2.00	2.00	1.60	1.60	3.90	2.00	.80	1.00	1.10	1.00	1.40	1.80
25	2.00	2.00	1.60	1.80	3.90	2.00	.80	1.10	1.00	1.00	1.40	1.80
26	2.00	1.90	1.50	2.00	3.50	1.90	.90	1.10	1.00	1.20	1.40	1.80
27	2.00	1.80	1.40	2.40	3.40	1.90	.90	1.10	1.00	1.20	1.40	1.80
28	2.00	1.90	1.30	2.50	3.50	1.80	.90	1.10	1.00	1.10	1.40	1.80
29	2.00	.....	1.30	2.50	3.50	1.70	1.00	1.10	1.10	1.10	1.40	1.80
30	2.00	.....	1.30	2.50	3.50	1.60	1.10	1.10	1.10	1.10	1.40	1.80
31	2.00	.....	1.30	.....	3.40	.....	1.20	1.10	.....	1.10	.....	1.80

RIO GRANDE AT EMBUDO, N. MEX.

This station, established in 1889, is about 300 feet east of the railroad station at Embudo. It is described in Water-Supply Paper No. 50, page 2[illegible]. The results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 350. During 1901 the following discharge measurements were made by P. E. Harroun:

List of discharge measurements of Rio Grande at Embudo, N. Mex.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1901.	*Feet.*	*Sec.-ft.*	1901.	*Feet.*	*Sec.-ft.*
February 21	7.95	543	September 24	7.25	274
March 27	7.70	399	October 9	7.40	358
April 8	7.80	477	October 24	7.40	342
April 24	8.20	679	November 6	7.40	350
July 11[a]	7.30	267	November 19	7.40	336
July 25	7.50	338	December 5	7.65	439
August 23	7.40	339	December 19	7.60	420
September 6	7.50	381			

[a] Approximate.

Daily gage height, in feet, of Rio Grande at Embudo, N. Mex., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	7.50	7.70	8.10	7.60	10.10	10.95	7.95	7.70	7.55	7.30	7.40	7.70
2	7.50	7.70	8.10	7.65	10.55	10.70	7.80	7.65	7.50	7.30	7.40	7.70
3	7.50	7.70	8.10	7.70	10.75	10.55	7.80	7.50	7.55	7.30	7.40	7.65
4	7.50	7.70	8.10	7.70	10.90	10.35	7.60	7.50	7.60	7.30	7.40	7.65
5	7.45	7.70	8.10	7.70	10.40	10.15	7.70	7.65	7.55	7.30	7.40	7.80
6	7.40	7.70	8.15	7.70	9.95	10.05	7.55	7.60	7.50	7.75	7.40	7.80
7	7.45	7.70	8.20	7.70	9.85	10.05	7.50	7.70	7.50	7.55	7.40	7.80
8	7.50	7.70	8.20	7.75	9.75	10.05	7.50	8.80	7.50	7.50	7.40	7.65
9	7.50	7.70	8.20	7.80	9.75	10.25	7.40	8.30	7.80	7.45	7.40	7.65
10	7.50	7.70	8.10	7.70	9.80	10.35	7.35	8.00	7.75	7.40	7.40	7.45
11	7.50	7.70	8.10	7.70	10.00	10.30	7.30	7.95	7.65	7.40	7.50	7.50
12	7.55	7.60	8.05	7.70	10.15	10.15	7.30	7.65	7.60	7.40	7.45	7.55
13	7.60	7.60	8.00	7.70	10.25	10.00	7.20	7.60	7.55	7.40	7.40	7.55
14	7.60	7.60	8.00	7.70	10.40	9.75	7.20	7.50	7.50	7.35	7.40	7.50
15	7.60	7.60	8.00	7.70	10.50	9.60	7.25	7.65	7.50	7.30	7.40	7.50
16	7.60	7.60	8.00	7.70	10.55	9.45	7.25	7.90	7.40	7.30	7.40	7.45
17	7.60	7.60	8.00	7.75	10.45	9.30	7.20	7.60	7.40	7.30	7.40	7.55
18	7.50	7.70	8.00	7.75	10.40	9.05	7.20	7.60	7.40	7.30	7.40	7.60
19	7.50	7.85	8.00	7.75	10.55	8.85	7.10	7.50	7.35	7.30	7.40	7.60
20	7.50	8.05	7.80	7.85	10.75	8.75	7.15	7.50	7.30	7.30	7.40	7.60
21	7.55	8.10	7.70	7.90	11.20	8.70	7.15	7.50	7.30	7.30	7.40	7.60
22	7.60	8.15	7.70	7.90	11.75	8.70	7.10	7.45	7.30	7.30	7.40	7.60
23	7.60	8.15	7.70	7.90	12.00	8.70	7.55	7.40	7.30	7.30	7.40	7.65
24	7.65	8.15	7.70	8.00	11.80	8.65	8.30	7.45	7.30	7.35	7.40	7.65
25	7.70	8.15	7.60	8.40	11.45	8.50	7.85	7.50	7.30	7.40	7.40	7.60
26	7.70	8.10	7.60	8.75	11.20	8.60	7.70	8.10	7.30	7.40	7.50	7.55
27	7.70	8.10	7.60	9.45	10.95	8.45	9.95	7.45	7.30	7.55	7.65	7.60
28	7.70	8.10	7.60	9.75	10.95	8.25	7.85	7.40	7.30	7.40	7.70	7.55
29	7.70	.....	7.60	9.80	11.00	8.15	7.70	7.30	7.30	7.40	7.70	7.60
30	7.70	.....	7.65	9.95	11.00	7.95	7.70	7.35	7.30	7.40	7.70	7.65
31	7.70	.....	7.60	.....	11.00	.....	7.70	7.70	.....	7.40	.....	7.65

RIO GRANDE AT RIO GRANDE, N. MEX.

This station, established February 3, 1895, is about one-fourth of a mile above the railroad station at Rio Grande and at the head of White Rock Canyon. It is described in Water-Supply Paper No. 50, page 350. Results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 351. During 1901 the following measurements were made by P. E. Harroun:

List of discharge measurements of Rio Grande at Rio Grande, N. Mex.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1901.	*Feet.*	*Sec.-ft.*	1901.	*Feet.*	*Sec.-ft.*
March 8	5.70	934	September 5	5.30	647
April 10	5.40	670	September 26	4.60	299
April 26	7.40	2,383	October 11	5.05	447
July 10[a]	4.70	233	October 26	4.90	358
July 27	6.00	1,248	November 8	4.90	385
August 7	6.10	1,251	November 21	4.90	431
August 22	5.25	624	December 7	5.30	575

[a] Meter gave out; results approximate.

Daily gage height, in feet, of Rio Grande at Rio Grande, N. Mex., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4.90	5.05	5.60	5.05	9.75	9.15	5.35	5.90	5.45	4.65	5.05	5.10
2	4.75	5.15	5.65	5.10	10.15	8.85	5.30	5.05	5.00	4.65	5.05	5.10
3	4.75	5.15	5.75	5.10	9.90	8.45	5.40	5.00	4.80	4.75	5.00	5.10
4	4.85	5.05	5.95	5.20	9.40	8.30	5.20	4.30	6.25	4.80	5.00	5.00
5	4.90	5.10	5.80	5.20	9.05	8.15	5.20	6.40	5.45	4.75	4.95	5.10
6	4.90	5.15	5.80	5.20	8.80	7.95	5.10	6.15	5.20	6.60	5.00	5.20
7	5.05	5.15	5.75	5.20	8.85	7.85	5.10	6.00	5.25	5.55	4.90	5.30
8	5.15	5.25	5.65	5.15	8.85	7.65	5.05	6.85	4.95	5.60	4.90	5.15
9	5.15	5.25	5.80	5.30	8.80	7.65	4.90	5.65	6.95	5.30	4.95	5.00
10	4.90	5.15	5.60	5.25	8.80	7.75	4.90	5.40	7.10	5.00	5.00	4.90
11	4.95	5.15	5.65	5.40	8.75	7.70	4.85	5.40	5.65	4.95	5.00	5.00
12	4.95	5.15	5.45	5.25	8.80	7.65	4.70	5.30	5.25	4.95	5.10	4.85
13	4.85	5.15	5.40	5.25	8.70	7.45	4.70	5.20	5.15	4.90	5.15	4.80
14	5.05	5.15	5.30	5.45	9.35	7.15	5.55	5.20	5.05	4.85	5.05	4.70
15	4.95	5.20	5.30	5.70	9.45	7.05	4.70	5.25	4.95	4.75	5.00	4.50
16	5.05	5.20	5.20	5.80	9.50	7.00	5.25	5.40	4.85	4.80	4.90	4.55
17	4.95	5.15	5.60	5.90	9.25	6.85	4.70	5.45	4.80	4.80	4.85	4.60
18	5.05	5.15	5.55	5.70	9.25	6.70	4.65	5.25	4.75	4.85	4.90	4.75
19	4.95	5.25	5.60	5.70	9.35	6.45	4.55	6.80	4.80	4.85	4.90	5.20
20	4.90	5.85	5.40	5.65	9.40	6.30	4.55	6.95	4.75	4.90	4.90	5.10
21	4.90	5.95	5.40	5.90	9.95	6.30	4.60	5.40	4.75	4.85	4.90	5.10
22	4.90	5.95	5.40	6.20	60.40	6.30	5.15	4.95	4.60	4.95	4.85	5.00
23	5.05	5.95	5.45	6.75	10.35	6.25	4.90	4.75	4.55	4.90	4.85	4.90
24	5.15	5.70	5.30	6.85	10.25	6.15	4.95	4.75	4.60	4.90	4.80	5.10
25	5.15	5.65	5.30	7.35	9.40	6.15	6.15	5.20	4.65	4.95	4.90	5.05
26	5.15	5.65	5.20	8.10	9.40	6.00	6.15	4.95	4.55	4.90	4.90	5.05
27	5.25	5.55	5.15	8.65	9.20	5.95	6.95	5.20	4.60	4.80	4.90	4.90
28	5.20	5.70	5.15	8.70	9.20	5.90	5.80	5.05	4.55	4.95	5.05	4.75
29	5.25	.....	5.10	8.75	9.10	5.70	7.10	4.95	4.55	4.95	5.10	4.85
30	5.15	.....	5.05	9.25	9.10	5.55	6.60	4.90	4.55	5.00	5.10	4.90
31	4.95	.....	5.00	.....	9.15	.....	6.60	6.05	.....	5.05	.....	5.15

RIO GRANDE NEAR SAN MARCIAL, N. MEX.

This station, established January 29, 1895, is at the railroad bridge, a half mile south of the town. It is described in Water-Supply Paper No. 50, page 351. During the high water of September, 1900, the gage was swept away, since which time a graduated rod has been used, measuring down from the bridge for each reading.

Results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 352. During 1901 the following measurements of discharge were made by P. E. Harroun and the hydrographers for the International (Water) Boundary Commission:

List of discharge measurements of Rio Grande near San Marcial, N. Mex.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1901.	*Feet.*	*Sec.-ft.*	1901.	*Feet.*	*Sec.-ft.*
February 5	7.12	421	March 12	7.40	503
February 6	7.25	368	March 14	7.40	390
February 8	7.30	368	March 15	7.32	359
February 9	7.25	353	March 18	7.08	249
February 11	7.47	563	March 19	6.99	150
February 12	7.50	541	March 20	6.87	118
February 14	7.42	463	March 22	6.75	90
February 15	7.47	480	March 25	6.73	85
February 18	7.30	344	March 26	6.63	63
February 19	7.30	329	March 27	6.52	50
February 21	7.27	284	March 29	6.39	25
February 22	7.30	290	March 30	6.33	25
February 24	7.80	701	April 1	6.30	23
February 25	7.85	921	April 2	6.30	20
February 26	8.02	1,115	Do	6.30	22
Do	8.00	1,269	April 4	6.10	11
February 27	7.65	701	April 5	6.40	35
March 1	7.45	532	April 8	6.30	25
March 4	7.35	329	April 9	6.20	12
March 5	7.16	321	April 11	6.00	6
March 7	7.30	370	April 12	6.05	9
March 10	7.55	469	April 13	5.90	4
March 11	7.41	425	April 15	6.00	10
March 12	7.46	488	April 16	5.90	5

List of discharge measurements of Rio Grande, etc.—Continued.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1901.	*Feet.*	*Sec.-ft.*	1901.	*Feet.*	*Sec.-ft.*
April 18	5.90	6	June 18	7.80	1,136
April 19	5.90	5	June 20	7.70	783
April 21	6.90	146	June 22	7.60	498
April 22	7.10	209	June 24	7.30	356
April 23	7.10	185	June 26	7.20	210
April 24	7.00	145	June 28	7.20	178
April 26	6.80	85	June 30	6.90	80
Do	8.00	1,009	July 2	6.70	42
April 27	8.00	998	July 3	7.00	150
April 28	8.90	2,403	July 5	6.60	29
April 29	9.10	2,946	August 20	10.85	9,112
April 30	9.10	3,419	August 23	7.00	809
May 1	9.10	3,526	August 24	6.20	290
May 2	9.10	3,622	August 26	6.10	219
May 3	9.70	4,696	August 28	6.40	284
May 4	9.90	5,847	August 29	6.00	126
May 5	9.70	5,531	August 30	6.10	120
May 7	8.90	3,398	September 1	5.90	90
May 8	8.90	3,421	September 2	6.30	186
May 9	8.90	3,647	September 3	6.20	157
May 10	8.90	2,877	Do	6.00	94
May 11	8.60	3,074	September 4	6.20	159
May 12	8.80	3,252	September 5	7.70	1,463
May 13	9.00	3,428	September 6	6.65	388
May 14	9.10	3,516	September 22	5.70	51
May 15	9.20	4,238	October 7	6.80	517
May 16	9.40	4,547	October 28	6.30	101
May 18	9.20	4,370	November 10	6.55	150
May 20	9.20	4,241	November 20	6.70	297
May 22	9.10	4,397	November 22	6.80	267
May 23	9.30	4,873	November 23	6.70	239
May 24	9.80	5,583	November 25	6.90	233
May 26	9.70	5,600	November 27	6.80	244
May 28	9.30	4,469	November 29	6.80	247
May 30	9.10	3,597	December 2	6.80	273
June 1	9.40	4,326	December 4	6.90	310
June 2	9.80	4,884	December 6	7.00	366
June 4	8.90	3,795	December 9	7.00	282
June 6	8.50	3,145	December 11	7.25	398
June 8	8.20	1,920	December 17	6.90	260
June 10	8.10	1,804	December 19	6.80	181
June 12	8.20	1,688	December 23	7.20	392
June 14	8.10	1,601	December 26	7.10	309
June 16	8.20	1,796			

Daily gage height, in feet, of Rio Grande near San Marcial, N. Mex., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	5.35	7.10	7.40	6.30	9.10	9.35	6.80	7.95	5.95	4.90	6.69	6.80
2	6.20	7.10	7.30	6.30	9.10	9.70	6.65	7.15	6.05	5.35	6.55	6.80
3	6.65	7.10	7.30	6.20	9.65	9.25	6.75	6.80	5.95	5.10	6.70	6.90
4	6.90	7.15	7.35	6.20	9.80	9.00	6.80	6.35	6.15	5.00	6.70	6.90
5	6.95	7.15	7.20	6.30	9.70	8.60	6.55	6.25	7.00	4.90	6.70	7.00
6	6.70	7.15	7.25	6.20	9.20	8.45	6.25	6.15	7.00	5.35	6.70	6.95
7	6.60	7.25	7.30	6.40	8.85	8.40	5.90	8.50	6.55	7.10	6.70	7.00
8	6.30	7.35	7.40	6.30	8.85	8.15	5.95	7.75	6.35	8.10	6.70	7.10
9	6.80	7.35	7.45	6.25	8.85	8.10	5.70	7.85	7.27	7.15	6.70	6.90
10	6.90	7.20	7.50	6.15	8.90	8.15	5.55	8.10	9.17	6.75	6.60	7.00
11	7.25	7.40	7.45	5.95	8.65	8.05	5.40	7.30	9.65	6.65	6.60	7.20
12	7.10	7.50	7.40	6.00	8.60	8.20	5.30	7.00	8.40	6.60	6.60	7.00
13	7.30	7.45	7.45	5.95	8.95	8.15	5.20	6.80	7.60	6.50	6.75	7.05
14	7.15	7.45	7.40	6.05	9.10	8.10	5.10	6.60	6.95	6.40	6.90	7.05
15	7.15	7.40	7.30	5.90	9.20	8.10	7.50	6.65	6.55	6.40	8.07	6.95
16	7.15	7.30	7.30	5.85	9.40	8.20	6.60	6.55	6.40	6.40	7.65	6.95
17	7.20	7.35	7.20	5.95	9.25	7.90	5.80	6.35	6.30	6.40	7.25	6.95
18	7.20	7.30	7.10	5.90	9.20	7.75	5.35	6.50	6.15	6.30	6.90	6.90
19	7.30	7.25	7.00	5.90	9.30	7.75	5.30	6.95	6.00	6.30	6.80	6.90
20	7.25	7.30	7.90	5.85	9.20	7.70	5.20	9.96	5.90	6.30	6.70	6.90
21	7.15	7.35	6.80	6.80	9.20	7.65	5.10	8.55	5.75	6.30	6.80	6.95
22	7.20	7.30	6.80	7.15	9.10	7.50	5.00	7.35	5.70	6.30	6.80	7.20
23	7.20	7.25	6.80	7.10	9.30	7.35	5.75	6.90	5.60	6.30	6.75	7.25
24	7.20	7.55	6.80	7.00	9.65	7.20	7.10	6.35	5.50	6.30	6.75	7.30
25	7.10	7.85	6.75	6.90	9.70	7.20	9.80	6.25	5.40	6.30	6.75	7.25
26	7.15	7.95	6.65	7.40	9.60	7.15	8.10	6.15	5.30	6.30	6.80	7.15
27	7.15	7.65	6.50	7.95	9.45	7.10	7.90	6.35	5.10	6.30	9.80	7.05
28	7.10	7.50	6.50	8.75	9.15	7.10	8.50	6.25	5.00	6.30	6.75	7.10
29	7.20	.....	6.40	9.00	8.95	7.00	8.90	6.00	4.90	6.30	6.80	7.10
30	7.30	.....	6.40	9.15	9.05	6.85	8.70	6.05	4.90	6.30	6.90	7.15
31	7.25	.....	6.40	.....	9.25	.....	9.10	5.95	.....	6.30	.....	7.20

RIO GRANDE NEAR EL PASO, TEX.

Measurements of the Rio Grande have been made at this place for a long time, during the last three years under the direction of W. W. Follett and P. D. Cunningham, consulting engineers of the International (Water) Boundary Commission. The present station is at Courchesne's limekiln, 4 miles north of El Paso. It is described in Water-Supply Paper No. 50, page 352. Results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 353. During 1901 the following discharge measurements were made by T. N. Courchesne:

List of discharge measurements of Rio Grande near El Paso, Tex.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1901.	*Feet.*	*Sec.-ft.*	1901.	*Feet.*	*Sec.-ft.*
February 5	5.70	96	May 29	11.00	3,966
February 9	5.60	71	June 5	10.60	3,316
February 12	5.50	55	June 7	10.20	2,585
February 14	5.70	87	June 10	9.10	1,642
February 16	6.20	175	June 15	8.30	834
February 18	6.00	115	June 18	8.20	795
February 21	5.60	68	July 29	8.20	877
February 23	5.50	57	August 1	10.20	3,074
February 28	6.80	288	August 3	9.90	2,425
March 1	7.10	412	August 5	8.20	944
March 4	6.10	138	August 10	9.20	1,729
March 16	5.50	58	August 12	9.00	1,339
May 2	8.20	938	August 23	10.10	2,962
May 4	9.10	1,526	September 13	10.10	2,646
May 6	10.10	2,386	September 15	9.10	1,880
May 8	10.40	3,185	September 17	7.70	648
May 11	9.90	2,166	September 19	7.00	188
May 14	9.70	1,983	October 26	7.10	389
May 16	9.90	2,274	November 4	7.10	303
May 18	10.20	2,680	November 6	6.00	65
May 20	10.55	3,065	November 9	6.00	65
May 21	10.60	3,209	November 18	7.70	721
May 23	10.50	3,076	December 4	6.30	132

Dailg gage height, in feet, of Rio Grande near El Paso, Tex., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	5.00	4.70	7.10	4.70	5.95	10.50	4.90	10.20	5.60	4.80	5.75	6.30
2	5.00	4.70	6.70	4.70	8.35	10.50	4.90	10.05	5.25	4.80	6.50	6.30
3	5.00	5.25	6.35	4.70	8.95	10.50	4.90	9.85	5.05	4.80	7.85	6.30
4	5.05	5.70	6.15	4.70	9.10	10.50	4.90	8.85	5.00	4.80	7.05	6.30
5	5.15	5.70	5.85	4.70	9.60	10.65	4.90	8.35	5.00	4.80	6.65	6.30
6	5.10	5.70	5.70	4.70	10.10	10.80	4.90	7.90	5.00	4.80	6.10	6.30
7	4.90	5.70	5.50	4.70	10.35	10.30	4.90	7.50	4.90	4.80	5.85	6.30
8	4.90	5.60	5.40	4.70	10.35	9.90	4.90	6.90	4.90	4.80	5.85	6.30
9	4.90	5.60	5.30	4.70	10.05	9.35	4.90	6.60	4.90	4.80	6.00	6.30
10	4.90	5.60	5.20	4.70	9.95	9.10	4.90	9.05	4.95	4.80	6.00	6.30
11	4.90	5.60	5.05	4.70	9.90	8.95	4.90	9.15	5.60	6.15	5.90	6.30
12	4.90	5.50	4.90	4.70	9.75	8.85	4.90	9.00	7.65	7.35	5.90	6.30
13	4.90	5.50	4.80	4.70	9.60	8.65	4.90	8.70	10.10	6.90	5.70	6.30
14	4.90	5.70	4.70	4.70	9.70	8.35	4.90	8.25	9.40	6.50	5.90	6.30
15	4.90	5.90	4.95	4.70	9.80	8.25	4.90	7.90	0.05	6.10	7.00	6.30
16	4.90	6.25	5.35	4.70	9.90	8.20	4.90	7.45	8.50	5.70	6.45	6.30
17	4.90	6.15	5.50	4.70	10.10	8.40	4.90	7.20	7.60	5.40	6.30	6.30
18	4.90	5.95	5.65	4.70	10.20	8.10	4.90	6.90	7.25	5.20	7.70	6.30
19	4.90	5.80	5.55	4.70	10.25	8.00	4.90	6.50	6.95	5.20	7.70	6.30
20	4.90	5.65	5.40	4.70	10.45	7.50	4.90	6.40	6.60	5.20	7.40	6.30
21	4.90	5.60	5.25	4.70	10.55	7.10	4.90	6.35	6.20	5.20	7.35	6.30
22	4.90	5.50	4.95	4.70	10.55	6.70	4.90	7.90	5.85	5.20	6.95	6.30
23	4.90	5.50	4.90	4.70	10.50	6.40	4.90	10.05	5.45	5.20	6.80	6.30
24	4.90	5.50	4.70	4.70	10.50	6.10	4.90	9.25	5.10	5.30	6.70	6.30
25	4.90	5.40	4.70	4.70	10.50	5.90	4.90	8.40	5.00	7.05	6.45	6.30
26	4.90	5.30	4.70	4.70	10.60	5.65	4.90	8.00	4.90	6.80	6.40	6.30
27	4.70	5.20	4.70	4.70	10.60	5.60	4.90	7.40	4.90	6.25	6.40	6.30
28	4.70	6.70	4.70	4.70	10.85	5.45	8.70	7.10	4.90	5.90	6.30	6.30
29	4.70	------	4.70	4.70	11.00	5.25	8.15	6.70	4.90	5.65	6.30	6.30
30	4.70	------	4.70	4.70	11.00	5.05	9.40	6.40	4.90	5.60	6.30	6.30
31	4.70	------	4.70	------	10.65	------	10.00	6.00	------	5.50	------	------

LOWER RIO GRANDE.

During 1900 the International (Water) Boundary Commission established a number of gaging stations on the Rio Grande below El Paso, Tex., and on some of its tributary streams, as noted below. This Commission has had charge of the investigation looking toward the building of an international dam at El Paso, and the stations were established in order to obtain data regarding the fluctuations of the lower river to determine questions which had arisen in connection with hydrographic problems. Information regarding the river at the several localities where stations have been established has been furnished through the courtesy of Gen. Anson Mills, chairman of the International (Water) Boundary Commission. The stations are as follows in order downstream: Rio Grande near Fort Hancock, Tex.; Rio Grande 7 miles above Presidio, Tex.; Rio Grande 6 miles below Presidio, Tex.; Rio Grande near Langtry, Tex.; Pecos River near Moorhead, Tex.; Devils River at Devilsriver, Tex.; Rio Grande near Devilsriver, Tex.; and Rio Grande near Eagle Pass, Tex.

RIO GRANDE NEAR FORT HANCOCK, TEX.

This station was established by the International (Water) Boundary Commission March 27, 1900. It is 1½ miles southeast of Fort Hancock, on the Southern Pacific Railroad, in the El Paso Valley, and is about 55 miles below El Paso. The gage record for 1900 is published in Water-Supply Paper No. 50, page 354. Results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 354. During 1901 the following measurements of discharge were made by James Hague and C. W. Healy:

List of discharge measurements of Rio Grande near Fort Hancock, Tex.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1901.[a]	*Feet.*	*Sec.-ft.*	1901.	*Feet.*	*Sec.-ft.*
May 8	5.65	1,877	June 17	3.80	469
May 10	6.20	2,151	June 19	3.70	401
May 13	4.60	1,616	June 21	3.00	150
May 15	4.40	1,456	June 24	1.20	43
May 17	5.40	1,706	June 26	.50	13
May 20	5.70	2,005	August 11	5.35	1,295
May 22	5.80	2,064	August 12	5.02	1,170
May 24	6.00	2,233	August 13	5.60	1,469
May 27	6.10	2,287	August 16	3.20	419
May 29	6.20	2,397	August 17	2.80	284
May 31	6.60	2,663	August 24	6.05	1,701
June 3	6.40	2,669	August 25	5.55	1,344
June 5	6.40	2,496	August 30	2.20	100
June 7	6.30	2,281	September 13	2.30	159
June 10	5.40	1,531	September 14	6.33	1,783
June 12	4.70	1,184	September 15	5.70	1,535
June 14	4.00	542			

[a] No measurements were made from Jan. 1 to May 8; June 28 to July 30; Sept. 15 to Dec. 31, 1901.

Daily gage height, in feet, of Rio Grande near Fort Hancock, Tex., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	(a)	(a)	(a)	(a)	(a)	6.70	(a)	6.20	1.30	(a)	1.50	1.65
2	(a)	(a)	(a)	(a)	(a)	6.55	(a)	5.90	.90	(a)	1.75	1.75
3	(a)	(a)	(a)	(a)	(a)	6.35	(a)	6.30	1.10	(a)	2.20	1.55
4	(a)	(a)	(a)	(a)	(a)	6.30	(a)	6.10	.90	(a)	4.80	1.60
5	(a)	(a)	(a)	(a)	4.50	6.40	(a)	4.35	.50	(a)	3.90	1.70
6	(a)	(a)	(a)	(a)	5.30	6.50	(a)	2.00	.25	(a)	3.50	1.70
7	(a)	(a)	(a)	(a)	5.60	6.35	(a)	1.15	.25	(a)	3.10	1.70
8	(a)	(a)	(a)	(a)	5.70	6.75	(a)	.65	(a)	(a)	2.70	1.80
9	(a)	(a)	(a)	(a)	6.35	5.70	(a)	.50	(a)	(a)	2.30	1.80
10	(a)	(a)	(a)	(a)	6.20	5.40	(a)	.20	1.80	(a)	1.90	1.70
11	(a)	(a)	(a)	(a)	5.65	5.00	(a)	5.25	1.20	(a)	1.50	1.85
12	(a)	(a)	(a)	(a)	4.50	4.60	(a)	4.80	.55	(a)	1.20	2.10
13	(a)	(a)	(a)	(a)	4.55	4.20	(a)	5.50	2.30	(a)	1.20	2.20
14	(a)	(a)	(a)	(a)	4.30	3.90	(a)	4.50	6.40	1.55	1.10	2.05
15	(a)	(a)	(a)	(a)	4.45	3.70	(a)	3.80	5.70	1.35	1.70	1.90
16	(a)	(a)	(a)	(a)	4.70	3.60	(a)	3.10	5.35	1.15	1.65	1.90
17	(a)	(a)	(a)	(a)	5.40	3.80	(a)	2.70	4.50	.95	1.55	1.80
18	(a)	(a)	(a)	(a)	5.60	3.70	(a)	2.20	3.30	.75	1.70	1.95
19	(a)	(a)	(a)	(a)	5.65	3.70	(a)	1.70	2.50	.55	1.75	2.50
20	(a)	(a)	(a)	(a)	5.70	3.55	(a)	1.30	2.10	.35	3.80	2.90
21	(a)	(a)	(a)	(a)	5.80	2.90	(a)	1.05	1.70	1.25	3.45	3.30
22	(a)	(a)	(a)	(a)	5.85	2.50	(a)	.85	1.55	1.75	2.95	3.10
23	(a)	(a)	(a)	(a)	5.80	1.90	(a)	.65	1.35	2.50	2.70	2.70
24	(a)	(a)	(a)	(a)	[b]6.00	1.10	(a)	6.15	1.15	3.35	2.15	2.30
25	(a)	(a)	(a)	(a)	5.90	1.00	(a)	5.50	.95	1.90	1.85	1.95
26	(a)	(a)	(a)	(a)	5.95	.50	(a)	4.30	.75	2.80	1.55	1.75
27	(a)	(a)	(a)	(a)	6.10	.50	(a)	3.30	.55	3.90	1.75	1.55
28	(a)	(a)	(a)	(a)	6.35	a.20	(a)	2.60	.35	3.20	1.90	1.35
29	(a)	(a)	(a)	(a)	6.25	.....	(a)	2.30	.15	2.40	1.80	1.30
30	(a)	(a)	(a)	(a)	6.65	.....	4.20	2.10	(a)	1.90	1.55	1.30
31	(a)	(a)	(a)	(a)	6.60	.....	5.20	1.70	.....	1.55	.....	1.30

[a] No flow. [b] Gage changed.

RIO GRANDE ABOVE PRESIDIO, TEX.

This station was established by the International (Water) Boundary Commission April 4, 1900. It is 7 miles above Presidio and above the mouth of Concho River, one of the principal tributaries of the Rio Grande, and is about 200 miles below El Paso. Its location is far enough above the mouth of Concho River to be free from the effects of backwater from that stream. The gage record for 1900 is published in Water-Supply Paper No. 50 page 355. Results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 354. During 1901 the following measurements of discharge were made by S. D. Church:

List of discharge measurements of Rio Grande above Presidio, Tex.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1901.[a]	*Feet.*	*Sec.-ft.*	1901.[a]	*Feet.*	*Sec.-ft.*
May 10	3.55	673	June 6	5.30	1,521
May 11	4.80	933	June 8	5.30	1,560
May 14	4.10	936	June 11	5.05	1,330
May 16	3.90	899	June 13	3.95	770
May 18	3.80	818	June 15	3.15	447
May 21	4.30	1,050	June 18	2.60	269
May 23	4.50	1,112	June 20	2.50	230
May 25	4.70	1,224	June 22	2.30	176
May 27	4.80	1,287	June 25	2.10	141
May 29	4.80	1,313	June 27	1.80	72
May 30	4.95	1,364	June 29	1.40	14
June 4	5.50	1,620	July 13	2.85	363

[a] No measurements were made during January, February, March, and April.
[b] River rose 0.4 foot during measurement.

List of discharge measurements of Rio Grande above Presidio, Tex.—Continued.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1901.	*Feet.*	*Sec.-ft.*	1901.	*Feet.*	*Sec.-ft.*
July 16		9	September 24	1.90	104
July 23	2.30	163	September 26	1.70	58
July 25	2.15	140	September 28	1.70	64
July 27	4.65	1,294	October 8	2.15	211
July 30	2.05	84	October 24	2.85	410
August 3	2.75	425	October 26	2.00	163
August 6	4.90	1,274	October 29	1.90	137
August 7	4.45	1,042	November 2	2.75	341
August 8	3.55	615	November 5	1.80	108
August 10	2.70	336	November 7	1.40	46
August 13	2.65	323	November 11	1.90	160
August 15	3.70	727	November 13	1.60	100
August 17	3.30	528	November 16	1.40	46
August 20	2.60	319	November 19	0.00	30
August 22	1.90	86	November 24	2.40	293
August 24	1.70	61	November 26	2.20	212
August 27	4.80	1,072	November 28	2.00	173
August 29	3.25	483	December 3	1.40	69
September 3	2.25	125	December 5	1.40	74
September 5	6.45	2,087	December 7	1.30	67
September 7	2.70	251	December 10	1.20	62
September 10	1.60	30	December 12	1.30	64
September 12	6.25	2,053	December 14	1.30	59
September 14	2.20	104	December 17	1.40	81
September 19	3.55	702	December 19	1.50	96
September 21	2.60	303	December 21	1.40	76

Daily gage height, in feet, of Rio Grande above Presidio, Tex., for 1901.

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1		5.05	(b)	0.55	1.85	3.25	4.35	1.60
2		5.35	(b)	2.50	2.00	1.55	2.90	1.50
3		5.40	(b)	2.85	2.85	(b)	1.80	1.40
4		5.45	(b)	4.55	4.80	(b)	2.05	1.35
5		5.35	(b)	4.85	5.80	(b)	1.70	1.40
6		5.30	(b)	4.90	4.50	(b)	1.55	1.40
7		5.20	(b)	4.40	3.90	3.30	1.30	1.35
8		5.35	(b)	2.95	1.85	2.25	1.75	1.20
9	(a)	5.40	(b)	2.75	1.45	(b)	2.15	1.20
10	3.50	5.50	(b)	2.70	1.55	(b)	2.00	1.20
11	4.55	5.00	(b)	2.45	3.25	.80	1.85	1.20
12	4.55	4.15	(b)	2.55	5.25	(b)	1.65	1.30
13	4.45	3.90	3.95	2.50	3.30	(b)	1.60	1.30
14	3.95	3.60	2.80	3.05	2.10	(b)	1.50	1.30
15	3.95	3.15	1.75	3.50	1.80	(b)	1.40	1.40
16	4.00	2.95	(b)	4.55	1.55	(b)	1.40	1.40
17	3.85	2.75	(b)	3.30	3.25	(b)	1.30	1.40
18	3.90	2.65	(b)	3.25	5.05	(b)	1.20	1.40
19	4.00	2.50	(b)	2.70	3.65	(b)	0.00	1.50
20	4.15	2.50	(b)	2.95	2.85	(b)	0.00	1.50
21	4.30	2.45	2.55	2.05	2.60	(b)	0.00	1.40
22	4.50	2.30	2.75	1.85	2.15	3.70	0.00	1.40
23	4.55	2.30	2.20	1.75	2.05	4.25	1.50	1.30
24	4.60	2.15	2.15	1.55	1.90	2.90	2.45	1.60
25	4.65	2.05	1.85	.50	1.80	2.00	2.20	1.60
26	4.80	1.95	2.80	.90	1.85	3.25	2.20	1.55
27	4.85	1.40	3.90	4.80	1.95	2.90	2.10	1.55
28	4.85	1.05	2.45	4.30	1.65	2.45	2.00	1.80
29	4.85	1.35	3.20	3.30	3.20	2.45	1.85	1.45
30	5.00	(b)	1.85	2.75	4.00	1.60	1.70	1.50
31	5.00		1.45	2.20		2.25		1.30

[a] River dry from January 1, to May 9, 1901.

[b] No flow.

RIO GRANDE BELOW PRESIDIO, TEX.

This station was established by the International (Water) Boundary Commission April 8, 1900. It is 6 miles below Presidio, also below the mouth of Concho River, and about 215 miles below El Paso. It is at the western end of the canyon section of the Rio Grande. The gage record for 1900 is published in Water-Supply Paper No. 50, page 355. Results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 355. The following discharge measurements were made by S. D. Church during 1901:

List of discharge measurements of Rio Grande below Presidio, Tex.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1901.	*Feet.*	*Sec.-ft.*	1901.	*Feet.*	*Sec.-ft.*
January 2	4.90	202	July 24	6.95	940
January 4	4.90	195	July 26	6.85	943
January 7	4.80	196	July 29	8.30	2,094
January 10	4.80	190	August 2	8.35	2,488
January 14	4.80	179	August 5	8.80	2,994
January 16	4.80	178	August 9	7.30	1,427
January 19	4.80	175	August 12	7.70	1,637
January 23	4.70	172	August 14	7.20	1,221
January 25	4.70	171	August 16	8.15	2,218
January 28	4.70	162	August 21	7.15	1,372
February 1	4.70	175	August 13	6.50	994
March 15	4.70	157	August 26	6.20	791
March 18	4.60	147	August 28	8.05	2,076
March 20	4.60	135	September 2	6.40	754
March 22	4.50	124	September 4	8.45	2,660
March 25	4.40	109	September 6	6.50	804
March 27	4.00	86	September 9	8.00	1,809
April 1	4.20	75	September 11	9.05	2,948
April 3	4.10	74	September 13	8.65	2,870
April 5	4.10	57	September 16	9.70	4,754
April 8	4.00	58	September 18	9.95	5,304
April 10	4.00	57	September 20	8.65	2,903
April 12	3.90	42	September 23	7.55	1,617
April 15	3.80	33	September 25	7.00	1,083
April 18	3.70	29	September 27	6.55	872
April 22	3.70	27	October 2	6.50	881
April 25	3.70	21	October 4	5.70	431
May 1	3.60	22	October 7	7.90	707
May 4	3.60	26	October 9	6.40	474
May 7	3.60	24	October 11	5.80	337
May 13	6.60	1,041	October 14	6.60	388
May 15	6.50	837	October 16	6.20	493
May 17	6.30	748	October 18	5.90	391
May 20	6.50	938	October 21	5.80	332
May 22	6.70	1,054	October 25	9.95	4,864
May 24	6.80	1,119	October 28	8.35	2,942
May 28	7.00	1,252	November 1	7.10	1,107
June 3	7.40	1,530	November 4	6.50	771
June 5	7.30	1,516	November 6	6.30	641
June 7	7.30	1,444	November 9	6.50	744
June 12	6.65	1,104	November 12	6.00	554
June 14	6.05	[a] 743	November 15	5.70	451
June 17	6.95	545	November 18	5.50	411
June 19	5.30	281	November 20	5.50	383
June 21	5.20	255	November 22	5.50	353
June 24	4.90	166	November 25	5.85	565
June 26	4.80	139	November 27	5.70	504
July 1	4.20	47	December 2	5.50	367
July 5	3.90	24	December 4	5.40	347
July 8	4.00	29	December 6	5.40	346
July 10	5.25	261	December 9	5.30	293
July 12	5.00	193	December 13	5.20	282
July 15	5.80	458	December 16	5.10	266
July 19	5.70	412	December 20	5.20	280
July 22	7.25	908			

[a] Back water from Rio Alamo retarded flow.

Daily gage height, in feet, of Rio Grande below Presidio, Tex., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4.90	4.70	5.50	4.20	3.60	7.10	4.10	9.00	6.70	6.70	7.55	5.60
2	4.90	4.70	5.40	4.10	3.60	7.30	4.10	8.70	6.50	6.55	7.35	5.50
3	4.90	4.70	5.40	4.10	3.60	7.40	4.15	8.95	6.15	6.00	6.75	5.40
4	4.90	4.70	5.30	4.20	3.60	7.40	3.95	8.85	8.15	5.75	6.60	5.40
5	4.80	4.70	5.20	4.10	3.60	7.30	3.95	8.70	8.20	5.60	6.40	5.40
6	4.80	4.70	5.20	4.10	3.60	7.30	4.35	8.65	6.90	7.30	6.30	5.40
7	4.80	4.70	5.10	4.10	3.60	7.30	4.15	8.35	8.00	7.50	6.15	5.35
8	4.80	4.70	5.10	4.10	4.45	7.30	4.00	7.65	8.40	7.20	6.10	5.30
9	4.80	4.70	5.00	4.10	4.35	7.30	3.95	7.25	7.90	6.35	6.50	5.30
10	4.80	4.70	4.90	4.00	4.35	7.40	5.25	7.65	7.75	6.05	6.30	5.30
11	4.80	4.70	4.90	3.90	6.25	6.90	5.15	7.70	9.25	5.80	6.15	5.20
12	4.80	4.70	4.80	3.90	6.55	6.60	5.10	7.50	9.90	6.10	6.00	5.20
13	4.80	4.70	4.85	3.80	6.45	6.20	6.95	7.45	8.55	6.45	5.90	5.20
14	4.80	4.70	4.70	3.70	6.50	6.00	7.40	7.10	7.90	6.50	5.80	5.20
15	4.80	4.70	4.70	3.70	6.40	5.70	5.70	7.70	7.65	6.40	5.70	5.15
16	4.80	4.70	4.60	3.70	6.35	5.45	5.50	7.85	9.65	6.20	5.70	5.10
17	4.80	4.70	4.60	3.70	6.20	6.15	5.50	8.45	9.75	6.15	5.70	5.10
18	4.80	5.20	4.60	3.70	6.25	5.70	5.65	7.70	10.00	5.95	5.60	5.15
19	4.80	5.45	4.60	3.70	6.40	5.25	5.65	7.80	9.40	5.90	5.60	5.20
20	4.80	6.10	4.60	3.70	6.50	5.20	5.90	7.65	8.75	5.80	5.50	5.20
21	4.70	6.05	4.50	3.70	6.60	5.20	9.05	7.10	8.35	5.90	5.50	5.15
22	4.70	5.90	4.50	3.70	6.70	5.05	7.05	6.70	8.00	8.35	5.50	5.10
23	4.70	5.80	4.45	3.70	6.80	4.90	7.50	6.55	7.60	10.30	5.40	5.05
24	4.70	5.80	4.40	3.70	6.85	4.90	7.35	6.30	7.25	10.30	6.10	5.25
25	4.70	5.80	4.40	3.70	6.90	4.80	8.60	6.40	6.95	9.40	5.90	5.30
26	4.70	5.70	4.30	3.70	7.00	4.70	8.15	6.50	6.75	8.70	5.80	5.25
27	4.70	5.60	4.00	3.70	7.10	4.65	9.10	7.75	6.55	8.30	5.80	5.30
28	4.70	5.50	4.00	3.70	7.10	4.45	8.60	8.05	6.35	7.85	5.75	5.50
29	4.70	.....	4.00	3.70	7.10	4.25	8.45	7.60	6.30	7.45	5.70	5.20
30	4.70	.....	4.15	3.70	7.10	4.20	9.00	7.25	8.10	7.45	5.60	5.20
31	4.70	.....	4.20	3.70	7.10	.....	9.35	6.80	.....	.....	.....	5.15

RIO GRANDE NEAR LANGTRY, TEX.

This station was established by the International (Water) Boundary Commission in April, 1900. It is located one-half mile south of Langtry station on the Southern Pacific Railroad, and is about 440 miles below El Paso, Tex., at the eastern end of the canyon section of the Rio Grande, and a short distance to the west of the mouth of Pecos River, one of the principal tributaries of the Rio Grande.

The gage record for 1900 is published in Water-Supply Paper No. 50, page 357. Results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 355. During 1901 the following measurements of discharge were made by J. D. Dillard and W. D. Greet:

List of discharge measurements of Rio Grande near Langtry, Tex.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1901.	*Feet.*	*Sec.-ft.*	1901.	*Feet.*	*Sec.-ft.*
January 1	1.10	611	March 11	1.20	677
January 5	1.10	623	March 15	1.10	616
January 11	1.10	618	March 21	.95	528
January 18	1.05	593	March 26	.85	462
January 23	1.05	588	April 16	.70	380
January 28	1.05	583	April 22	.70	371
February 1	1.05	572	April 30	.80	461
February 6	1.00	543	May 6	.90	515
February 11	1.00	541	May 8	.80	448
February 15	1.00	537	May 13	.80	450
February 20	1.00	532	May 17	1.60	1,181
February 25	1.50	919	May 22	1.50	1,124
March 1	1.45	893	May 23	2.30	1,893
March 6	1.30	764	June 4	2.00	1,614

List of discharge measurements of Rio Grande near Langtry, Tex.—Continued.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1901.	*Feet.*	*Sec.-ft.*	1901.	*Feet.*	*Sec.-ft.*
June 12	2.10	1,842	September 16	3.10	3,599
June 15	2.10	1,868	September 20	5.00	[a]6,374
June 17	1.90	1,603	September 24	2.80	3,173
June 23	1.30	954	September 29	2.00	1,795
July 1	.90	579	October 5	1.90	1,704
July 4	.85	533	October 7	1.65	1,282
July 10	.85	544	October 11	2.20	2,078
July 13	.75	499	October 19	1.40	1,158
July 17	1.60	1,290	October 22	1.40	1,152
July 19	1.55	1,246	October 25	2.40	2,519
July 23	1.80	1,589	October 28	4.95	8,118
July 24	2.50	2,448	November 4	2.05	1,987
July 26	2.90	3,508	November 7	1.90	1,708
July 27	2.80	3,336	November 10	1.60	1,358
August 5	2.80	3,404	November 15	1.55	1,297
August 12	2.40	2,684	November 18	1.45	1,190
August 15	2.30	1,862	November 24	1.30	957
August 21	2.70	2,468	November 27	1.30	928
August 27	1.90	1,360	December 7	1.25	898
September 2	2.20	1,834	December 10	1.20	897
September 7	2.70	2,594	December 15	1.15	827
September 11	2.50	2,617			

[a]Approximate.

Daily gage height, in feet, of Rio Grande near Langtry, Tex., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.10	1.00	1.50	0.80	0.90	2.00	0.90	3.00	2.40	1.95	2.50	1.40
2	1.10	1.00	1.50	.80	.90	2.00	.90	3.10	2.20	1.00	2.30	1.40
3	1.10	1.00	1.50	.80	.90	2.00	.90	3.30	1.95	1.70	2.05	1.30
4	1.10	1.00	1.50	.80	.90	2.15	.90	3.25	1.85	1.75	2.05	1.30
5	1.10	1.00	1.30	.80	.90	2.30	.90	2.90	1.80	1.85	2.00	1.30
6	1.10	1.00	1.30	.80	.85	2.35	.90	2.90	1.70	1.65	1.90	1.30
7	1.10	1.00	1.30	.80	1.00	2.40	.90	2.90	2.70	1.65	1.90	1.25
8	1.10	1.00	1.30	.70	1.00	2.45	.90	3.00	8.45	1.70	1.75	1.25
9	1.10	1.00	1.30	.70	.90	2.50	.90	3.00	4.75	3.85	1.70	1.25
10	1.10	1.00	1.30	.70	.80	2.30	.90	2.90	3.00	2.65	1.65	1.20
11	1.10	1.00	1.25	.70	.80	2.30	.90	2.80	2.35	2.35	1.55	1.20
12	1.10	1.00	1.20	.70	.80	2.10	.90	2.60	2.90	1.90	1.50	1.20
13	1.10	1.00	1.20	.70	.80	2.10	.90	2.35	3.85	1.70	1.55	1.20
14	1.10	1.00	1.15	.70	.80	2.00	1.20	2.30	3.75	1.70	1.60	1.20
15	1.10	1.00	1.10	.70	.80	2.10	1.70	2.30	3.50	1.35	1.55	1.15
16	1.10	1.00	1.10	.70	.80	2.05	2.20	2.00	3.10	1.30	1.50	1.15
17	1.05	1.00	1.10	.70	1.65	1.90	1.85	1.80	2.85	1.30	1.50	1.15
18	1.00	1.00	1.10	.70	1.70	1.90	1.60	1.60	2.70	1.30	1.45	1.10
19	1.00	1.00	1.05	.70	1.70	1.60	1.55	2.30	2.60	1.35	1.40	1.10
20	1.00	1.00	1.00	.70	1.70	1.50	1.50	2.85	4.25	1.50	1.40	1.10
21	1.00	1.00	1.00	.70	1.70	1.40	1.00	2.70	4.30	1.45	1.35	1.10
22	1.00	1.00	1.00	.70	1.55	1.40	1.70	2.45	3.80	1.35	1.30	1.10
23	1.10	1.00	.90	.70	1.70	1.30	1.80	2.25	3.10	1.30	1.30	1.10
24	1.10	1.25	.90	.70	1.80	1.20	1.95	2.35	3.10	1.75	1.30	1.10
25	1.10	1.50	.90	.70	2.65	1.00	2.45	2.25	2.95	2.50	1.30	1.10
26	1.10	1.50	.90	.70	2.90	1.00	2.45	1.90	2.50	1.70	1.30	1.10
27	1.00	1.50	.90	1.25	2.60	1.00	2.85	1.85	2.30	1.75	1.30	1.10
28	1.00	1.50	.90	.85	2.30	1.00	2.10	1.60	2.10	4.25	1.30	1.05
29	1.00	.....	.90	1.50	2.30	.90	2.90	1.50	2.00	3.45	1.35	1.00
30	1.00	.....	.90	.80	2.30	.90	2.10	1.15	2.00	3.05	1.45	.95
31	1.00	.....	.80	.....	2.15	.....	2.50	2.50	.....	2.75	.....	.95

PECOS RIVER NEAR PECOS, TEX.

The gaging station is at the Margueretta flume, about 6 miles above the city of Pecos, and is described in Water-Supply Paper No. 50, page 358. The observer is W. H. Denis, who also gages the river, the Margueretta flume, and the west valley ditch, the computations of

discharge being made by T. U. Taylor. The following measurements were made during 1901:

Discharge measurements of Pecos River, Margueretta flume, and west valley ditch, near Pecos, Tex., for 1901.

Date.	Gage height.	Pecos River discharge.	Margueretta flume discharge.	West valley ditch discharge.
1901.	*Feet.*	*Sec.-ft.*	*Sec.-ft.*	*Sec.-ft.*
July 5	1.2	39	155	19
July 10	.8	18	122	18
July 15	1.7	67	182	23
July 21	.7	16	127	18
August 6	5	831	143	18
August 11	2.1	95	216	19
August 16	6.6	1,350	216	19
August 23	2.9	181	155	24
September 1	2.2	108	106	17
September 16	7.9	1,940	120	11
September 24	3	184	108	9
October 3	2.25	109	107	8
October 10	2.4	128	108	7
October 16	2.4	118	106	5
October 24	3.2	273	105	8
November 4	10.3	3,120	97	9

Daily gage height, in feet, of Pecos River near Pecos, Tex., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.00	3.00	3.20	1.50	5.05	4.85	1.00	2.65	2.15	2.95	3.55	4.10
2	2.00	3.00	3.20	1.50	4.60	4.90	1.00	5.30	2.25	2.60	5.55	4.00
3	2.15	3.05	3.20	1.50	2.85	3.30	1.00	5.10	2.30	2.28	9.35	4.00
4	2.20	3.00	3.20	1.55	2.30	2.85	1.00	5.10	4.55	2.15	10.15	4.00
5	2.35	3.00	3.20	1.50	2.05	2.45	1.20	5.10	7.35	2.15	10.35	4.00
6	2.55	3.05	2.95	1.45	1.70	1.95	1.30	5.00	6.35	2.10	10.60	4.00
7	2.90	3.15	2.80	1.35	1.45	2.10	1.25	4.65	4.10	2.90	12.60	4.00
8	3.35	3.20	2.65	1.30	1.30	2.75	.95	4.20	3.10	2.85	11.75	4.00
9	3.30	3.20	2.60	1.25	1.50	2.75	.85	3.25	2.85	2.50	10.40	4.00
10	3.20	3.25	2.50	1.20	1.55	2.40	.80	2.55	2.75	2.40	9.20	3.60
11	3.15	3.40	2.50	1.20	1.30	2.30	.80	2.10	2.85	2.40	8.45	3.15
12	3.65	3.70	2.50	1.15	.95	2.30	.80	3.25	5.35	2.85	7.90	3.10
13	3.65	3.75	2.50	1.00	.85	2.25	.80	4.20	6.55	2.80	7.15	2.85
14	3.60	3.90	2.25	1.00	1.00	1.70	.80	5.95	7.80	3.05	6.50	2.70
15	3.30	3.80	2.15	.95	2.05	1.35	1.75	6.40	8.40	3.80	6.15	2.70
16	2.75	3.85	2.00	.75	1.75	1.15	1.15	6.55	7.90	3.50	5.35	2.70
17	2.95	3.90	1.95	.70	1.65	1.55	.95	6.70	7.15	3.20	5.30	2.70
18	2.70	3.90	1.95	.70	1.30	1.95	.95	6.75	6.25	2.95	4.90	2.70
19	2.60	3.95	1.95	.70	.95	1.70	.90	6.65	5.35	2.75	4.15	3.00
20	2.60	4.00	1.85	.70	.80	1.45	.90	7.95	4.35	2.80	4.15	2.85
21	3.15	4.00	1.80	.70	1.65	1.15	.90	5.35	4.05	2.95	4.95	2.70
22	3.20	3.10	1.75	.70	3.00	.85	.90	3.80	3.95	3.00	4.95	2.70
23	2.75	3.10	1.70	.70	2.30	.90	.85	3.05	3.70	3.25	4.90	2.55
24	2.70	2.90	1.70	.70	1.95	1.35	4.40	2.60	2.95	3.25	4.90	2.50
25	2.70	3.30	1.65	.70	1.95	1.40	6.10	2.15	2.75	3.35	4.80	2.50
26	2.85	3.50	1.60	.70	1.25	1.35	5.20	2.00	2.65	3.20	4.70	2.50
27	3.00	3.50	1.60	.70	1.05	1.10	4.45	2.00	2.55	4.05	4.65	2.50
28	3.00	3.50	1.70	.70	1.90	1.05	3.15	3.00	2.15	3.55	4.60	2.50
29	3.00	.....	1.75	.65	3.55	1.30	2.95	3.00	2.70	3.20	4.55	2.50
30	3.00	.....	1.70	4.00	3.10	1.10	3.05	2.75	2.00	3.15	4.30	2.50
31	3.00	.....	1.65	.....	4.50	.....	2.15	2.30	.....	3.35	.....	3.95

PECOS RIVER NEAR MOORHEAD, TEX.

This station was established by the International (Water) Boundary Commission in April, 1900. It is near Moorhead, immediately above the high bridge of the Southern Pacific Railway. The gage record for 1900 is published in Water-Supply Paper No. 50, page 362. Results of measurements for 1900 will be found in the Twenty-second Annual

Report, Part IV, page 356. The following discharge measurements were made by J. D. Dillard and W. D. Greet during 1901:

List of discharge measurements of Pecos River near Moorhead, Tex.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1901.	*Feet.*	*Sec.-ft.*	1901.	*Feet.*	*Sec.-ft.*
January 4	1.50	438	July 25	1.30	268
January 12	1.55	454	July 28	1.20	288
January 19	1.70	572	August 2	1.90	730
January 24	1.55	536	August 10	1.85	662
January 29	1.55	530	August 17	1.25	366
February 2	1.50	499	August 23	2.50	1,129
February 7	1.55	541	August 29	1.50	528
February 12	1.60	570	September 4	1.20	354
February 16	1.60	563	September 14	------	875
February 21	1.70	611	September 19	2.95	1,342
February 26	1.70	602	September 23	2.80	1,444
March 2	1.50	485	September 29	1.70	646
March 7	1.50	489	October 1	1.70	656
March 12	1.50	482	October 6	1.60	620
March 16	1.45	450	October 9	1.90	849
March 20	1.35	420	October 16	1.40	487
March 27	1.25	380	October 18	1.30	454
April 18	1.00	285	October 24	1.45	545
April 24	1.00	280	October 29	1.50	586
April 27	1.00	287	November 3	2.20	1,073
May 5	1.00	282	November 9	3.25	1,898
May 9	1.50	454	November 12	3.60	2,306
May 16	1.00	291	November 14	3.80	2,536
May 18	1.00	287	November 15	3.80	2,544
May 24	1.00	295	November 17	3.85	2,635
May 31	1.00	293	November 20	2.90	1,547
June 5	1.00	302	November 23	2.25	1,134
June 16	1.40	372	November 26	2.30	1,209
June 22	.90	222	November 29	2.30	1,210
June 29	.90	189	December 1	2.30	1,202
July 3	.90	183	December 4	2.20	1,000
July 9	.85	170	December 9	2.00	943
July 14	1.85	658	December 14	1.90	927
July 20	.80	162	December 19	1.70	688
July 22	.90	177			

Daily gage height, in feet, of Pecos River near Moorhead, Tex., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.50	1.50	1.50	1.20	1.00	1.00	0.90	1.80	1.20	1.70	1.40	2.30
2	1.50	1.50	1.50	1.20	1.00	1.00	.90	1.85	1.20	1.70	1.70	2.20
3	1.50	1.50	1.50	1.20	1.00	1.00	.90	1.65	1.20	1.70	2.15	2.20
4	1.50	1.50	1.50	1.20	1.00	1.00	.90	1.50	1.20	1.65	1.80	2.20
5	1.50	1.50	1.50	1.10	1.00	1.00	.90	1.40	1.20	1.60	1.50	2.20
6	1.50	1.50	1.50	1.10	1.90	1.00	.90	1.40	1.20	1.60	1.40	2.20
7	1.50	1.50	1.50	1.10	1.90	1.00	1.20	1.30	1.20	1.60	1.40	2.00
8	1.50	1.50	1.50	1.10	1.90	1.50	1.20	1.20	9.20	1.80	1.50	2.00
9	1.50	1.50	1.50	1.10	1.50	1.50	.90	1.80	6.00	1.90	2.65	2.00
10	1.50	1.60	1.50	1.00	1.40	1.50	.80	1.85	4.00	1.75	3.60	1.90
11	1.50	1.60	1.50	1.00	1.40	1.50	.80	1.90	4.00	1.60	3.45	1.90
12	1.50	1.60	1.50	1.00	1.40	1.50	.80	1.90	2.75	1.60	3.60	1.90
13	1.50	1.60	1.50	1.00	1.30	1.50	1.80	1.90	1.90	1.60	3.75	1.90
14	1.60	1.60	1.50	1.00	1.30	1.50	2.80	1.75	1.80	1.60	3.70	1.95
15	1.60	1.60	1.50	1.00	1.20	1.50	1.80	1.60	1.80	1.60	3.90	1.90
16	1.60	1.60	1.50	1.00	1.00	1.40	1.40	1.60	1.80	1.45	3.80	1.90
17	1.60	1.60	1.40	1.00	1.00	1.40	1.40	1.30	1.80	1.50	3.85	1.90
18	1.70	1.65	1.40	1.00	1.00	1.40	.90	1.50	1.80	1.30	3.10	1.80
19	1.70	1.70	1.40	1.00	1.00	1.50	.90	1.80	2.40	1.30	2.90	1.70
20	1.65	1.70	1.35	1.00	1.00	1.50	.85	2.20	2.80	1.30	2.85	1.70
21	1.60	1.70	1.30	1.00	1.00	.95	.90	2.45	3.75	1.20	2.80	1.70
22	1.60	1.70	1.30	1.00	1.00	.90	.90	2.60	3.00	1.20	2.65	1.60
23	1.60	1.70	1.30	1.00	1.00	.90	1.70	2.45	2.80	1.20	2.25	1.60
24	1.60	1.70	1.30	1.00	1.00	.90	1.75	2.30	2.60	1.30	2.30	1.60
25	1.50	1.70	1.30	1.00	1.00	.90	1.20	2.50	2.00	1.40	2.30	1.50
26	1.50	1.70	1.30	1.00	1.00	.90	.85	2.70	1.80	1.40	2.30	1.50
27	1.50	1.65	1.25	1.00	1.00	.90	.80	2.15	1.60	1.40	2.30	1.50
28	1.50	1.60	1.20	1.00	1.00	.90	1.05	1.85	1.60	1.40	2.25	1.40
29	1.50	------	1.20	1.00	1.00	.90	1.20	1.45	1.70	1.35	2.25	1.40
30	1.50	------	1.20	1.00	1.00	.90	1.70	1.30	1.70	1.30	2.30	1.40
31	1.50	------	1.30	------	1.00	------	1.85	1.00	------	1.30	------	1.40

DEVILS RIVER AT DEVILSRIVER, TEX.

This station was established by the International (Water) Boundary Commission in April, 1900. It is opposite the Southern Pacific Railroad station at Devilsriver. The river is about 50 miles in length, has a perennial flow, and during flood periods is subject to great fluctuations. The gage record for 1900 is published in Water-Supply Paper No. 50, page 363. Results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 356. During 1901 the following measurements of discharge were made by J. D. Dillard and W. D. Greet:

List of discharge measurements of Devils River at Devilsriver, Tex.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1901.	*Feet.*	*Sec.-ft.*	1901.	*Feet.*	*Sec.-ft.*
January 4	2.50	847	June 14	2.20	591
January 10	2.50	835	June 21	2.20	592
January 21	2.50	834	June 28	2.20	585
January 30	2.45	808	July 2	2.20	583
February 4	2.45	804	July 8	2.20	579
February 14	2.40	747	July 15	2.20	577
February 18	2.50	832	July 31	2.20	573
February 22	2.50	842	August 8	2.20	596
March 4	2.45	769	August 17	2.10	515
March 13	2.40	724	August 29	2.05	509
March 27	2.40	752	September 30	2.10	517
April 18	2.30	668	October 3	2.10	516
May 3	2.30	656	October 26	2.10	517
May 10	2.30	656	November 5	2.10	522
May 15	2.30	670	November 21 [a]	2.10	512
June 2	2.30	666			

[a] No measurements were made during December.

Daily gage height, in feet, of Devils River at Devilsriver, Tex., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.50	2.40	2.50	2.40	2.30	2.30	2.20	2.20	2.10	2.10	2.10	2.10
2	2.50	2.40	2.50	2.40	2.30	2.30	2.20	2.20	2.10	2.10	2.10	2.10
3	2.50	2.40	2.50	2.40	2.30	2.30	2.20	2.20	2.15	2.10	2.10	2.10
4	2.50	2.40	2.50	2.40	2.30	2.30	2.20	2.20	2.10	2.10	2.10	2.00
5	2.50	2.40	2.40	2.40	2.30	2.30	2.20	2.20	2.05	2.10	2.10	2.00
6	2.50	2.40	2.40	2.40	2.30	2.30	2.20	2.20	2.10	2.10	2.10	2.00
7	2.50	2.40	2.40	2.30	2.30	2.20	2.20	2.20	2.10	2.10	2.10	2.00
8	2.50	2.40	2.40	2.30	2.30	2.20	2.20	2.20	2.10	2.10	2.10	2.00
9	2.50	2.40	2.40	2.30	2.30	2.20	2.20	2.20	2.35	2.10	2.10	2.00
10	2.50	2.40	2.40	2.30	2.30	2.20	2.20	2.20	2.20	2.10	2.10	2.00
11	2.50	2.40	2.40	2.30	2.30	2.20	2.20	2.30	2.10	2.10	2.10	2.00
12	2.50	2.40	2.40	2.30	2.30	2.20	2.40	2.25	2.10	2.10	2.10	2.00
13	2.50	2.40	2.40	2.30	2.30	2.20	2.20	2.25	2.10	2.10	2.10	2.05
14	2.50	2.40	2.40	2.30	2.30	2.20	2.20	2.25	2.10	2.10	2.10	2.10
15	2.50	2.40	2.40	2.30	2.30	2.20	2.20	2.20	2.10	2.10	2.10	2.10
16	2.50	2.40	2.40	2.30	2.30	2.20	2.20	2.20	2.10	2.10	2.10	2.10
17	2.50	2.50	2.40	2.30	2.30	2.20	2.20	2.10	2.10	2.10	2.10	2.10
18	2.50	2.50	2.40	2.30	2.30	2.20	2.20	2.10	2.10	2.10	2.10	2.10
19	2.50	2.50	2.40	2.30	2.30	2.20	2.20	2.05	2.10	2.10	2.10	2.10
20	2.50	2.50	2.40	2.30	2.30	2.20	2.20	2.00	2.10	2.10	2.10	2.00
21	2.50	2.50	2.40	2.30	2.30	2.20	2.20	2.00	2.10	2.10	2.10	2.00
22	2.50	2.50	2.40	2.30	2.30	2.20	2.20	2.00	2.10	2.10	2.10	2.00
23	2.50	2.50	2.40	2.30	2.30	2.20	2.20	2.10	2.10	2.10	2.10	2.00
24	2.50	2.50	2.40	2.30	2.30	2.20	2.20	2.00	2.10	2.10	2.10	2.00
25	2.50	2.50	2.40	2.30	2.30	2.20	2.20	2.00	2.10	2.10	2.10	2.00
26	2.50	2.50	2.40	2.30	2.30	2.20	2.20	2.00	2.10	2.10	2.10	2.00
27	2.50	2.50	2.40	2.30	2.30	2.20	2.20	2.00	2.10	2.10	2.10	2.00
28	2.50	2.50	2.40	2.30	2.30	2.20	2.20	2.10	2.10	2.10	2.10	2.00
29	2.50	.....	2.40	2.30	2.30	2.20	2.20	2.10	2.10	2.10	2.10	2.00
30	2.40	.....	2.40	2.30	2.30	2.20	2.20	2.10	2.10	2.10	2.10	2.00
31	2.40	.....	2.40	.....	2.30	.....	2.20	2.10	.....	2.10	.....	2.00

RIO GRANDE NEAR DEVILSRIVER, TEX.

This station was established by the International (Water) Boundary Commission in April, 1900. It is alongside the Southern Pacific Railroad track, about a half mile below the mouth of Devilsriver and about 480 miles below El Paso. The gage record for 1900 is published in Water-Supply Paper No. 50, page 364. Results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 357. During 1901 the following measurements of discharge were made by J. D. Dillard and W. D. Greet:

List of discharge measurements of Rio Grande near Devilsriver, Tex.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1901.	*Feet.*	*Sec.-ft.*	1901.	*Feet.*	*Sec.-ft.*
January 3	3.65	2,309	July 2	3.20	1,769
January 10	3.65	2,326	July 8	3.30	2,028
January 16	3.60	2,287	July 15	3.20	1,894
January 22	3.60	2,260	July 31	5.00	5,593
January 26	3.60	2,228	August 3	4.50	4,817
January 31	3.50	2,161	August 8	4.70	5,493
February 5	3.50	2,120	August 11	4.50	5,102
February 9	3.50	2,116	August 18	4.00	2,858
February 14	3.60	2,241	August 24	4.55	4,187
February 19	3.60	2,230	August 30	3.80	2,612
February 23	3.60	2,242	September 5	3.80	2,615
February 28	3.85	2,673	September 13	4.80	4,716
March 5	3.75	2,487	September 16	5.20	6,157
March 9	3.70	2,373	September 21	6.15	9,113
March 14	3.60	2,205	September 30	4.20	3,425
March 19	3.50	2,071	October 4	4.00	3,075
March 23	3.45	2,000	October 8	3.95	2,787
March 28	3.40	1,916	October 12	4.20	3,600
April 19	3.20	1,616	October 17	3.70	2,550
April 25	3.20	1,640	October 23	3.80	2,628
April 29	3.30	1,766	October 27	4.00	3,090
May 3	3.30	1,755	November 2	4.45	4,237
May 11	3.40	1,955	November 5	4.20	3,674
May 15	3.35	1,805	November 8	4.35	3,902
May 21	3.70	2,065	November 13	4.60	4,630
May 26	3.70	2,016	November 16	4.70	4,995
June 1	3.95	2,630	November 19	4.40	4,188
June 13	4.05	2,987	November 22	4.10	3,541
June 14	4.25	3,402	November 25	3.90	2,958
June 18	4.00	2,980	December 2	4.00	3,351
June 21	3.50	2,352	December 13	3.80	2,885
June 28	3.30	1,947	December 17	3.70	2,598

Daily gage height, in feet, of Rio Grande near Devilsriver, Tex., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.70	3.50	3.80	3.40	3.50	3.95	3.30	4.60	3.70	4.00	4.80	4.00
2	3.70	3.50	3.80	3.40	3.50	3.80	3.30	4.50	4.20	3.80	4.45	4.00
3	3.70	3.50	3.70	3.40	3.40	3.85	3.30	4.70	4.00	3.90	4.00	4.00
4	3.70	3.50	3.70	3.40	3.30	4.00	3.30	4.70	3.80	4.00	4.00	4.00
5	3.70	3.50	3.70	3.40	3.30	4.00	3.30	4.70	4.00	4.00	4.20	4.00
6	3.70	3.50	3.70	3.30	3.40	4.20	3.30	4.80	4.20	4.00	4.30	3.95
7	3.70	3.50	3.70	3.30	3.65	4.10	3.30	4.70	4.20	4.00	4.50	3.80
8	3.70	3.50	3.70	3.30	3.50	4.20	3.30	5.00	4.20	3.90	4.35	3.80
9	3.70	3.50	3.70	3.30	3.50	4.10	3.20	5.15	14.40	6.65	4.10	3.80
10	3.70	3.50	3.70	3.30	3.40	4.05	3.20	5.10	6.00	5.00	4.60	3.80
11	3.70	3.55	3.60	3.30	3.40	4.00	3.20	4.50	5.00	4.80	4.50	3.80
12	3.70	3.60	3.60	3.30	3.40	4.00	3.80	4.50	4.80	4.20	4.50	3.80
13	3.70	3.60	3.60	3.30	3.30	4.00	3.80	4.60	4.80	4.30	4.60	3.80
14	3.60	3.60	3.60	3.20	3.30	4.00	3.70	4.00	4.80	4.00	4.50	3.80
15	3.60	3.60	3.60	3.20	3.30	3.90	3.20	4.00	4.80	3.80	4.40	3.80
16	3.60	3.60	3.60	3.20	3.30	3.90	3.30	4.00	5.30	4.00	4.75	3.80
17	3.60	3.60	3.50	3.20	3.40	4.40	4.00	4.10	4.80	3.70	4.70	3.70
18	3.60	3.60	3.50	3.20	3.55	4.00	4.15	4.00	4.70	3.80	4.55	3.70
19	3.60	3.60	3.50	3.20	3.75	3.80	4.00	4.10	4.75	4.00	4.40	3.70
20	3.60	3.60	3.50	3.20	3.70	3.60	3.80	4.10	5.90	3.90	4.30	3.70
21	3.60	3.60	3.50	3.20	3.70	3.50	3.55	4.10	6.05	3.80	4.20	3.60
22	3.60	3.60	3.50	3.20	3.70	3.70	3.40	4.40	5.60	3.80	4.10	3.60
23	3.60	3.60	3.50	3.20	3.70	3.70	3.30	5.00	5.50	3.80	4.00	3.60
24	3.60	3.60	3.40	3.20	3.70	3.60	3.40	4.60	5.10	4.00	3.90	3.60
25	3.60	3.60	3.40	3.20	3.80	3.50	3.50	4.40	5.00	4.00	3.90	3.60
26	3.60	3.95	3.40	3.20	3.80	3.40	3.70	4.40	4.80	4.60	3.90	3.60
27	2.60	3.90	3.40	3.20	4.30	3.40	3.90	4.10	4.50	4.00	3.95	3.60
28	3.60	3.90	3.40	3.30	4.00	3.30	4.45	4.00	4.50	6.80	4.00	3.60
29	3.60	.....	3.40	3.30	4.10	3.30	4.20	3.80	4.30	5.40	4.00	3.60
30	3.50	.....	3.40	3.50	4.10	3.30	4.00	3.80	4.20	5.20	4.00	3.60
31	3.50	.....	3.40	.....	4.10	.....	4.90	8.80	.....	4.80	.....	3.60

RIO GRANDE NEAR EAGLE PASS, TEX.

This station was established by the International (Water) Boundary Commission, in April, 1900. It is a half mile above the railway bridge between Eagle Pass and Ciudad Porfirio Diaz, Mexico, and about 540 miles below El Paso, Tex. The gage record for 1900 is published in Water-Supply Paper No. 50, page 365. Results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 357. During 1901 the following measurements of discharge were made by O. B. Powell and others:

List of discharge measurements of Rio Grande near Eagle Pass, Tex.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1901.	*Feet.*	*Sec.-ft.*	1901.	*Feet.*	*Sec.-ft.*
January 8	2.90	3,396	June 3	3.20	4,412
January 14	2.90	2,912	June 20	2.60	3,040
January 18	2.90	2,961	June 27	2.30	2,466
January 21	2.90	2,876	July 7	2.00	2,112
January 25	2.80	2,847	July 30	3.50	4,172
January 28	2.70	2,776	August 6	3.60	5,482
February 8	2.70	2,665	August 13	3.30	4,885
February 11	2.70	2,660	August 19	2.80	3,047
February 16	2.80	2,594	August 26	3.30	4,300
February 18	2.70	2,513	August 28	2.90	3,482
February 22	2.70	2,552	August 30	2.70	2,853
February 25	2.70	2,551	September 2	3.10	3,800
March 16	2.60	2,250	September 4	2.90	3,357
April 22	2.20	1,836	September 6	2.80	2,926
April 26	2.20	1,776	September 9	8.70	43,173
May 12	2.70	2,329	September 11	3.95	6,716
May 20	2.90	3,676	September 14	3.80	5,855
May 27	2.90	3,682	September 16	4.35	8,040

List of discharge measurements of Rio Grande near Eagle Pass, Tex.—Continued.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1901.	*Feet.*	*Sec.-ft.*	1901.	*Feet.*	*Sec.-ft.*
September 18	3.40	4,574	November 7	3.00	3,556
September 21	4.40	7,901	November 9	3.00	3,604
September 23	4.10	7,115	November 14	3.30	4,177
September 25	3.57	5,547	November 18	3.40	4,248
September 28	3.20	4,005	November 21	3.00	3,548
October 2	2.90	3,407	November 23	2.80	3,108
October 4	2.80	3,049	November 26	2.60	2,679
October 7	2.70	3,019	November 29	2.80	3,043
October 11	3.30	4,439	December 2	2.70	2,522
October 14	2.60	2,777	December 5	2.70	2,670
October 17	2.50	2,430	December 7	2.60	2,602
October 20	2.40	2,388	December 10	2.60	2,380
October 23	2.50	2,385	December 14	2.50	2,264
October 26	3.10	3,700	December 17	2.50	2,129
October 29	4.40	8,135	December 21	2.40	2,039
October 31	3.50	4,762	December 24	2.40	2,051
November 2	3.20	3,982	December 27	2.40	2,017
November 5	3.00	3,594	December 31	2.30	2,009

Daily gage height, in feet, of Rio Grande near Eagle Pass, Tex., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.90	2.80	2.70	2.40	2.90	3.00	2.20	3.20	2.75	2.90	3.35	2.70
2	2.90	2.80	2.80	2.40	2.80	3.65	2.20	3.55	3.15	2.90	3.20	2.70
3	2.90	2.80	2.70	2.40	2.80	3.15	2.20	3.40	3.10	2.80	3.15	2.70
4	2.90	2.80	2.70	2.40	2.80	3.25	2.15	3.40	2.90	2.80	3.00	2.70
5	2.90	2.80	2.70	2.40	2.75	3.35	2.10	3.65	2.80	2.80	3.00	2.70
6	2.90	2.80	2.70	2.40	2.70	3.20	2.00	3.55	2.75	2.85	2.90	2.65
7	2.90	2.80	2.70	2.30	2.70	3.20	2.00	3.50	2.70	2.70	2.95	2.60
8	2.90	2.80	2.70	2.30	2.70	3.20	2.20	3.60	2.75	2.60	2.90	2.60
9	2.90	2.80	2.70	2.30	3.00	3.25	2.20	3.60	7.15	2.65	3.05	2.60
10	2.90	2.80	2.70	2.40	2.85	3.30	2.20	3.60	4.30	4.25	3.30	2.60
11	2.90	2.80	2.70	2.45	2.75	3.20	2.10	3.50	3.90	3.35	3.30	2.50
12	2.90	2.80	2.70	2.40	2.70	3.15	2.20	3.40	3.45	3.05	3.30	2.50
13	2.90	2.80	2.70	2.40	2.70	3.00	2.15	3.30	3.45	2.85	3.30	2.50
14	2.90	2.80	2.70	2.30	2.60	3.00	2.00	3.30	4.45	2.65	3.30	2.50
15	2.90	2.80	2.60	2.30	2.60	3.05	2.40	3.20	3.80	2.60	3.40	2.50
16	2.90	2.80	2.60	2.30	2.60	3.10	2.30	3.10	4.25	2.50	3.40	2.50
17	2.90	2.70	2.60	2.25	2.60	3.05	2.20	3.00	3.65	2.50	3.40	2.50
18	2.90	2.70	2.60	2.20	2.55	3.00	2.65	2.90	3.35	2.40	3.40	2.50
19	2.90	2.70	2.60	2.20	2.70	2.85	2.90	2.80	3.30	2.40	3.25	2.45
20	2.90	2.70	2.50	2.20	2.90	2.65	2.65	2.80	3.65	2.40	3.10	2.40
21	2.90	2.70	2.50	2.20	2.90	2.50	2.45	3.25	4.30	2.50	3.00	2.40
22	2.90	2.70	2.50	2.20	2.80	2.50	2.40	3.50	4.35	2.50	2.90	2.40
23	2.90	2.70	2.50	2.20	2.90	2.50	2.55	3.50	4.05	2.50	2.80	2.40
24	2.85	2.70	2.50	2.20	2.85	2.50	2.35	3.50	3.85	2.50	2.70	2.40
25	2.80	2.70	2.50	2.20	3.10	2.45	2.60	3.50	3.55	2.50	2.70	2.40
26	2.80	2.70	2.50	2.20	2.90	2.30	2.95	3.40	3.40	2.95	2.60	2.40
27	2.80	2.70	2.50	2.20	2.90	2.30	2.95	3.15	3.30	2.85	2.60	2.40
28	2.80	2.70	2.50	2.20	3.15	2.20	2.90	2.95	3.15	3.75	2.70	2.35
29	2.80	.....	2.50	2.40	3.20	2.20	3.00	2.75	3.00	4.30	2.80	2.30
30	2.80	.....	2.50	2.55	3.20	2.20	3.10	2.70	2.95	3.85	2.75	2.30
31	2.80	.....	2.40	.....	3.10	.....	3.10	2.65	.....	3.55	.....	2.30

COLORADO RIVER DRAINAGE.

GREEN RIVER AT GREENRIVER, WYO.

This station was established May 2, 1895. It is at the pump house of the Union Pacific Railway Company. A description of the station was published in Water-Supply Paper No. 50, page 366. The following discharge measurements were made by A. J. Parshall during 1901:

March 22: Gage height, 0.70 foot; discharge, 543 second-feet.
April 8: Gage height, 0.65 foot; discharge, 505 second-feet.
April 28: Gage height, 2.05 feet; discharge, 2,039 second-feet.
May 9: Gage height, 2.70 feet; discharge, 3,438 second-feet.
May 23: Gage height, 5.10 feet; discharge, 12,048 second-feet.

Daily gage height, in feet, of Green River at Greenriver, Wyo., for 1901.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.
1	0.70	1.85	4.58	2.83	1.85	1.10	0.65
2	.80	2.07	4.38	2.88	1.85	1.10	.70
3	.80	2.35	4.25	2.90	1.95	1.05	.70
4	.70	2.85	4.18	2.83	2.20	1.03	.70
5	.70	3.05	3.98	2.73	1.95	1.00	.70
6	.70	2.85	3.75	2.80	1.90	.95	.....
7	.70	2.70	3.55	2.80	1.82	.95	.....
8	.70	2.70	3.33	2.70	2.15	.93	.....
9	.65	2.67	3.15	2.45	1.95	.90	.....
10	.65	2.73	3.05	2.33	1.75	.85	.....
11	.70	2.90	3.15	2.50	1.63	.80	.....
12	.75	3.05	3.10	2.50	1.58	.80	.....
13	.90	3.30	3.23	2.45	1.58	.80	.....
14	1.45	3.43	3.05	2.50	1.53	.75	.....
15	1.80	3.55	3.00	2.53	1.48	.70	.....
16	2.00	3.73	2.93	2.50	1.40	.70	.....
17	1.90	3.85	2.78	2.55	1.33	.70	.....
18	1.50	4.05	2.70	2.50	1.33	.70	.....
19	1.50	4.40	2.70	2.48	1.30	.70	.....
20	1.45	4.70	2.68	2.28	1.25	.70	.....
21	2.15	5.00	2.73	2.08	1.25	.70	.....
22	2.45	5.20	2.83	2.00	1.35	.70	.....
23	2.07	5.00	2.95	1.90	1.35	.70	.....
24	2.23	4.72	3.10	1.93	1.35	.68	.....
25	2.22	4.30	3.23	1.90	1.25	.65	.....
26	2.15	4.05	3.28	2.10	1.30	.65	.....
27	2.23	3.93	3.28	1.98	1.25	.70	.....
28	2.05	3.98	3.18	1.95	1.20	.70	.....
29	1.90	4.18	3.08	1.90	1.25	.68	.....
30	1.77	4.45	2.95	1.90	1.13	.65	.....
31	.....	4.50	.....	1.88	1.10	.....	.....

ASHLEY CREEK NEAR VERNAL, UTAH.

This station, established by C. T. Prall, on March 15, 1900, is described in Water-Supply Paper No. 50, page 368. Results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 365. It is located at the mouth of the canyon of the creek, 7½ miles above the town of Vernal, at the wagon bridge, at the ranch of the observer, E. Marett.

Dry Fork enters Ashley Creek about 2 miles above the gaging station. August 21 two measurements of its discharge were made. The first, 10 miles northwest of Dryfork post-office, gave a discharge of 96 second-feet; the second, 3 miles northwest of the same point, showed a discharge of 33 second-feet. On the same day Ashley Creek, immediately above the mouth of Dry Fork, was carrying 132 second-feet, and a short distance below it was carrying 128 second-feet.

During 1901 the following measurements of discharge were made at the main station by C. T. Prall and others:

List of discharge measurements of Ashley Creek near Vernal, Utah.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1901.	*Feet.*	*Sec.-ft.*	1901.	*Feet.*	*Sec.-ft.*
May 30	2.48	484	August 21	1.15	154
June 21	1.23	155	October 30	0.78	74

Daily gage height, in feet, of Ashley Creek near Vernal, Utah, for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	0.50	0.50	0.55	0.45	3.15	2.25	1.15	0.80	1.10	0.80	0.75	0.65
2	.50	.50	.55	.45	2.85	2.15	1.15	.80	1.10	.80	.75	.65
3	.50	.50	.55	.45	2.20	2.05	1.10	.90	1.10	.80	.75	.68
4	.50	.50	.55	.45	2.00	1.95	1.10	1.10	1.05	.80	.75	.70
5	.50	.50	.55	.45	1.95	1.85	1.10	.95	1.05	.80	.75	.70
6	.50	.50	.60	.45	2.10	1.75	1.00	2.35	1.05	.80	.75	.70
7	.50	.50	.60	.45	2.30	1.65	1.00	1.20	1.05	.80	.75	.70
8	.50	.50	.55	.45	2.40	1.65	1.00	1.40	1.00	.75	.75	.70
9	.50	.50	.55	.45	2.85	1.60	1.00	1.20	1.00	.75	.75	.70
10	.50	.50	.50	.45	3.10	1.58	1.05	1.15	1.00	.75	.75	.70
11	.50	.48	.50	.45	3.15	1.58	1.00	1.10	1.00	.75	.75	.70
12	.50	.48	.50	.47	3.05	1.58	1.00	1.10	1.00	.75	.75	.70
13	.50	.48	.50	.48	3.05	1.58	1.00	1.10	1.00	.75	.75	.70
14	.50	.48	.48	.50	3.05	1.55	1.00	1.10	1.00	.70	.75	.70
15	.50	.48	.48	.50	3.25	1.50	1.00	1.10	.90	.70	.75	.70
16	.50	.48	.48	.50	4.15	1.43	.95	1.08	.90	.70	.75	.70
17	.50	.48	.48	.50	4.25	1.40	.95	1.13	.85	.70	.75	.70
18	.50	.48	.48	.50	4.05	1.40	.80	1.05	.85	.70	.75	.70
19	.50	.48	.48	.50	4.15	1.35	.80	1.85	.85	.70	.75	.70
20	.50	.48	.48	.50	3.85	1.30	.80	1.35	.80	.70	.70	.65
21	.50	.48	.48	.55	3.40	1.25	.95	1.20	.80	.70	.70	.65
22	.50	.48	.48	.58	3.00	1.23	.80	1.15	.80	.70	.70	.65
23	.50	.48	.48	.80	2.70	1.20	.80	1.10	.80	.70	.70	.65
24	.50	.48	.48	1.30	2.55	1.20	.80	1.10	.80	.70	.65	.65
25	.50	.48	.48	1.80	2.65	1.20	1.05	1.10	.80	.70	.65	.65
26	.50	.53	.48	2.05	2.80	1.20	.85	1.05	.80	.70	.65	.65
27	.50	.53	.48	1.85	2.95	1.20	.80	1.10	.80	.80	.65	.65
28	.50	.53	.48	2.05	2.90	1.20	.80	1.10	.80	.75	.65	.65
29	.50	.....	.48	2.55	2.75	1.20	.80	1.10	.80	.75	.65	.65
30	.50	.....	.48	3.00	2.55	1.15	.80	1.10	.80	.75	.65	.65
31	.50	.....	.45	.....	2.40	.....	.80	1.10	.....	.75	.....	.65

UINTA RIVER NEAR WHITEROCKS, UTAH.

This station was established by C. C. Babb on September 16, 1899, in connection with the investigation of the water supply of the Uinta Indian Reservation. It is described in Water-Supply Paper No. 50, page 369. Results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 375.

Farm Creek is a small drainage entering this stream 5 miles northwest of Whiterocks. On May 14 it was gaged by L. V. Branch and gave a discharge of 34 second-feet.

During 1901 daily gage height records were not kept at the main station on the Uinta River in the canyon, but frequent measurements of discharge were made by C. T. Prall and others, as follows:

List of discharge measurements of Uinta River near Whiterocks, Utah.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1901.	*Feet.*	*Sec.-ft.*	1901.	*Feet.*	*Sec.-ft.*
April 8	0.88	110	August 26	1.20	261
April 15	1.00	142	September 2	1.20	263
April 22	1.03	153	September 9	1.08	210
April 29	1.10	186	September 16	1.00	178
May 7	1.28	254	September 23	.97	169
May 14	2.06	634	September 30	.95	170
May 31	1.72	496	October 7	.97	179
June 6	1.50	308	October 14	.90	165
June 15	1.40	278	October 21	.90	168
June 26	1.35	250	October 28	.97	185
July 1	1.40	255	November 4	.90	184
July 8	1.30	275	November 18	.80	144
July 15	1.18	242	November 25	.80	144
July 22	1.12	222	December 2	.83	153
July 29	1.19	233	December 9	[a] 1.30	185
August 5	1.12	229	December 17	([a])	189
August 12	1.12	226	December 23	[a] 1.10	137
August 19	1.50	464	December 30	[a] .95	122

[a] Ice.

WHITEROCKS RIVER NEAR WHITEROCKS, UTAH.

This station was established by C. C. Babb, September 15, 1899, in connection with the investigation of the water supply for the Uinta Indian Reservation. It is in the canyon of the river, about 10 miles above the Indian agency at Whiterocks, and is described in Water-Supply Paper No. 50, page 369. Results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 375. Daily gage readings were not maintained during 1901, but frequent measurements of discharge were made by C. T. Prall and others, as follows:

List of discharge measurements of Whiterocks River near Whiterocks, Utah.

Date	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1901.	*Feet.*	*Sec.-ft.*	1901.	*Feet.*	*Sec.-ft.*
April 9	0.80	40	August 27	1.25	139
April 23	1.05	72	September 3	1.22	126
April 30	1.30	139	September 10	1.10	96
May 6	1.40	162	September 17	1.05	83
May 15	2.55	647	September 24	1.05	83
June 1 [a]	1.57	279	October 1	1.00	78
June 7	1.60	197	October 8	1.00	82
June 16	1.40	156	October 15	.95	72
June 27	1.25	121	October 22	.90	68
July 2	1.20	93	October 29	1.00	82
July 9	1.17	104	November 5	.90	67
July 16	1.10	85	November 12	.80	55
July 23	1.05	81	November 19	.92	66
July 30	1.18	112	November 26	.88	66
August 6	1.22	128	December 3	.85	62
August 13	1.15	108	December 10	1.60	59
August 20	1.55	204	December 31	1.10	54

[a] Gage broken; gage height estimated.

UINTA RIVER AT FORT DUCHESNE, UTAH.

This station, which was established by C. C. Babb on September 14, 1899, is located at the highway bridge at the military post. It is described in Water-Supply Paper No. 50, page 370.

Two principal canals diverting water from this river above the gaging station, Canal No. 1 and Bench ditch, were measured twice during the year. Canal No. 1, on April 16, with a gage height of 0.72 foot, was discharging 7 second-feet; on August 6 it was discharging 32 second-feet. Bench ditch, on April 16, with a gage height of 0.80 foot, was discharging 13 second-feet; on August 6 it was discharging 40 second-feet.

Deep Creek enters Uinta River 2 miles above the gaging station. August 22 it was measured at a point 25 miles northeast of Fort Duchesne and 20 feet below the source of the stream, and a discharge of 6 second-feet was found.

Results of measurements at the main station for 1900 will be found in the Twenty-second Annual Report, Part IV, page 376. During

1901 the following measurements of discharge were made by C. T. Prall and others:

List of discharge measurements of Uinta River at Fort Duchesne, Utah.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1901.	*Feet.*	*Sec.-ft.*	1901.	*Feet.*	*Sec.-ft.*
April 4	2.62	88	August 28	2.92	194
April 13	2.65	105	September 4	2.79	146
April 20	2.60	95	September 11	2.65	106
April 28	2.80	166	September 18	2.63	103
May 3	3.26	340	September 25	2.65	105
May 15	4.04	1,089	October 2	2.63	102
May 29	3.92	883	October 12	2.65	106
June 5	3.30	330	Ootober 16	2.65	108
June 8	3.22	295	October 23	2.62	101
June 14	3.13	266	October 31	2.75	132
June 20	3.00	193	November 6	2.68	116
July 3	2.90	140	November 13	2.63	102
July 11	2.91	177	November 20	2.63	104
July 17	2.68	91	November 27	2.65	108
July 24	2.61	76	December 4	2.78	157
July 31	2.58	76	December 11 [a]	2.87	158
August 7	2.80	158	December 18 [a]	2.90	137
August 14	2.60	91	Deccmber 27 [a]	.....	126
August 23	2.92	190			

[a] Ice; results approximate.

Daily gage height, in feet, of Uinta River at Fort Duchesne, Utah, for 1901.

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.20	2.53	3.32	3.53	2.95	2.55	2.89	2.65	2.75	2.73
2	3.20	2.53	3.30	3.49	2.90	2.55	2.85	2.64	2.75	2.75
3	2.98	2.55	3.28	3.46	2.88	2.57	2.81	2.62	2.73	2.78
4	2.90	2.55	3.13	3.43	2.85	2.60	2.80	2.66	2.72	2.80
5	2.85	2.58	3.07	3.31	2.85	2.60	2.79	2.66	2.70	2.80
6	2.80	2.61	3.02	3.25	2.84	2.68	2.77	2.66	2.70	2.80
7	2.78	2.61	3.04	3.20	2.80	2.84	2.74	2.67	2.70	2.75
8	2.75	2.62	3.09	3.20	2.80	2.90	2.70	2.70	2.69	2.62
9	2.70	2.65	3.23	3.19	2.85	2.85	2.70	2.70	2.67	2.70
10	2.70	2.66	3.51	3.19	2.88	2.76	2.70	2.69	2.66	2.85
11	2.70	2.68	3.83	3.16	2.90	2.73	2.68	2.68	2.65	2.85
12	2.70	2.68	4.29	3.13	2.85	2.77	2.68	2.65	2.65	2.80
13	2.70	2.68	4.45	3.11	2.80	2.74	2.68	2.65	2.65	2.80
14	2.70	2.68	4.55	3.10	2.80	2.72	2.68	2.65	2.65	2.55
15	2.68	2.68	4.35	3.09	2.80	2.71	2.65	2.65	2.65	2.55
16	2.68	2.65	4.50	3.07	2.80	2.67	2.63	2.65	2.65	2.55
17	2.68	2.60	4.63	3.04	2.77	2.64	2.63	2.65	2.65	([a])
18	2.66	2.60	4.68	3.00	2.70	2.68	2.63	2.64	2.65	([a])
19	2.65	2.63	2.85	3.03	2.70	3.53	2.63	2.63	2.64	([a])
20	2.65	2.65	2.63	3.01	2.63	3.15	2.63	2.63	2.64	([a])
21	2.63	2.69	4.28	3.00	2.60	3.05	2.62	2.63	2.64	([a])
22	2.63	2.70	3.98	3.04	2.60	2.98	2.62	2.63	2.64	([a])
23	2.65	2.70	3.79	3.01	2.60	2.93	2.60	2.63	2.64	([a])
24	2.63	2.74	3.70	3.00	2.60	2.88	2.60	2.63	2.64	([a])
25	2.60	2.75	3.83	2.97	2.65	2.84	2.65	2.63	2.68	([a])
26	2.60	2.80	3.85	2.94	2.65	2.81	2.65	2.63	2.68	([a])
27	2.58	2.81	3.90	2.92	2.65	2.80	2.65	2.85	2.68	([a])
28	2.55	2.81	3.96	2.92	2.68	2.88	2.65	2.75	2.68	([a])
29	2.55	2.78	3.89	2.92	2.68	2.94	2.65	2.75	2.68	([a])
30	2.53	2.85	3.73	2.93	2.65	3.09	2.65	2.75	2.70	([a])
31	2.52	.....	3.63	.....	2.60	3.11	.....	2.75	.....	([a])

[a] Frozen.

UINTA RIVER AT OURAY SCHOOL, UTAH.

This station, established November 8, 1899, is at the highway bridge over the river near the Ouray School, on the Uinta Indian

Reservation. It is described in Water-Supply Paper No. 50, page 371. Results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 377. During 1901 the following measurements of discharge were made by C. T. Prall and others:

List of discharge measurements of Uinta River at Ouray School, Utah.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1901.	*Feet.*	*Sec.-ft.*	1901.	*Feet.*	*Sec.-ft.*
April 5	0.35	86	August 15	0.27	82
April 11	.48	107	August 29	1.06	260
April 18	.37	87	September 5	.70	159
April 25	.55	118	September 12	.49	114
May 16	3.75	2,177	September 19	.42	102
May 28	2.80	1,219	September 26	.52	126
June 5	1.68	396	October 3	.42	106
June 8	1.53	347	October 12	.52	122
June 13	1.30	266	October 17	.48	118
June 20	1.12	237	October 24	.50	119
July 4	.78	146	November 7	.55	136
July 13	.58	130	November 14	.53	131
July 18	.29	81	November 21	.56	135
July 25	.09	56	November 30	.55	133
August 1	.15	67	December 5	.60	143
August 8	.78	188	December 14 [a]	.....	.....

[a] Frozen.

Daily gage height, in feet, of Unita River at Ouray School, Utah, for 1901.

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	0.33	1.01	2.12	0.90	0.10	0.92	0.49	0.65	0.50
2	.....	.46	1.12	1.95	.90	.06	.80	.47	.64	.40
3	.....	.40	1.64	1.90	.90	.06	.73	.46	.64	.57
4	.....	.43	1.48	1.78	.80	.20	.69	.45	.64	.59
5	.....	.40	1.26	1.70	.70	.32	.68	.50	.61	.60
6	.....	.35	1.14	1.52	.70	.28	.64	.52	.60	.54
7	0.79	.40	1.08	1.50	.66	.60	.58	.54	.58	.60
8	.63	.41	1.21	1.55	.60	.79	.55	.59	.58	.50
9	.50	.40	1.44	1.50	.52	.70	.52	.58	.58	.25
10	.50	.50	1.86	1.45	.67	.54	.50	.57	.58	.45
11	.55	.48	2.46	1.40	.85	.45	.48	.55	.58	.66
12	.58	.48	3.00	1.40	.68	.38	.49	.54	.57	([a])
13	.44	.47	3.25	1.31	.60	.32	.50	.50	.52	([a])
14	.49	.47	3.20	1.38	.52	.30	.47	.48	.54	([a])
15	.50	.48	2.95	1.37	.48	.29	.47	.49	.55	([a])
16	.52	.50	3.50	1.25	.43	.31	.43	.48	.53	([a])
17	.51	.41	4.40	1.20	.40	.43	.41	.49	.55	([a])
18	.56	.47	4.20	1.15	.36	.35	.42	.49	.53	([a])
19	.49	.40	4.55	1.18	.28	.37	.40	.49	.50	([a])
20	.45	.40	4.30	1.12	.24	2.60	.42	.49	.50	([a])
21	.50	.48	3.70	1.10	.20	1.35	.42	.49	.54	([a])
22	.50	.56	3.15	1.14	.15	1.06	.39	.49	.53	([a])
23	.50	.57	2.70	1.12	.10	.92	.39	.49	.50	([a])
24	.43	.57	2.45	1.10	.10	.81	.41	.49	.56	([a])
25	.36	.61	2.49	1.10	.08	.75	.43	.50	.57	([a])
26	.48	.68	2.53	1.00	.22	.69	.50	.50	.50	([a])
27	.48	.70	2.80	.95	.16	.68	.52	.54	.51	([a])
28	.45	.71	2.80	.87	.38	.82	.50	.85	.50	([a])
29	.39	.69	2.73	.85	.35	1.03	.50	.65	.49	([a])
30	.41	.64	2.45	.85	.31	1.24	.50	.70	.55	([a])
31	.38	.....	2.22	.....	.20	1.20	.....	.70	.....	([a])

[a] Frozen.

LAKE CREEK NEAR MOUTH, UTAH.

This station was established by C. T. Prall July 3, 1900, and is described in Water-Supply Paper, No. 50, page 372. Results of

measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 380. It is located at the highway bridge near its mouth. The gage rod is a vertical board nailed to the west abutment on the lower side of the bridge. Bench mark No. 1 is a nail in the abutment opposite the 4.50-foot mark on the rod. Bench mark No. 2 is directly over the gage rod, and is the head of a wire nail in the southwest corner of the bridge upright. Its elevation is 5,066.58 feet. The elevation of the zero of the rod is 5,055.99 feet above sea level, according to the hydrographic survey datum. The elevation of bench mark No. 2 is 5,129 feet, referred to the topographic survey datum. The elevation of a regulation iron bench-mark post, 150 feet east of the bridge, is 5,127.55 feet, referred to the latter datum. The bed of the stream is composed of medium-sized cobblestones and forms a fair section. During flood stages measurements are made from the bridge, but at other periods they are made by wading at a point about 400 feet below. Daily gage heights were not taken, owing to the distance of the location from a reliable observer, but frequent measurements of discharge were made by C. T. Prall and others, as follows:

List of discharge measurements of Lake Creek, Utah, near mouth, for 1901.

Date.	Hydrographer.	Gage height.	Discharge.	Date.	Hydrographer.	Gage height.	Discharge.
1901.		*Feet.*	*Sec.-ft.*	1901.		*Feet.*	*Sec.-ft.*
Apr. 12	C. T. Prall	1.89	94	Aug. 24	C. T. Prall	2.35	256
Apr. 19	do	1.91	96	Aug. 30	do	2.33	252
Apr. 27	do	2.28	200	Sept. 6	do	2.15	175
May 4	do	2.53	290	Sept. 13	do	2.00	130
May 13	L. V. Branch	3.64	878	Sept. 20	do	2.00	129
May 18	do	5.90	2,491	Sept. 27	do	2.02	129
May 27	do	5.20	1,721	Oct. 4	do	1.98	120
June 4	do	3.45	735	Oct. 11	do	2.02	131
June 12	do	3.00	536	Oct. 18	do	1.96	116
June 19	do	2.90	494	Oct. 25	do	1.98	115
June 28	C. T. Prall	2.69	414	Nov. 1	do	2.05	133
July 6	do	2.45	276	Nov. 8	do	1.95	111
July 12	do	2.49	306	Nov. 15	do	1.95	113
July 19	do	2.20	179	Nov. 22	do	1.90	100
July 26	do	2.34	244	Nov. 29	do	1.95	106
Aug. 2	do	2.15	178	Dec. 6	do	1.95	109
Aug. 9	do	2.30	236	[a] Dec. 13	do		
Aug. 16	do	2.10	162				

[a] Frozen.

DUCHESNE RIVER AT PRICE ROAD BRIDGE, UTAH.

This station, established by C. C. Babb, on October 26, 1899, is 3 miles below the mouth of Lake Creek, at the highway bridge on the stage road from Price to Fort Duchesne. It is described in Water-Supply Paper, No. 50, page 370. Results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 385.

A new bench mark was placed in 1901, being a wire nail in the northwest corner of Clark's store, at an elevation of 5,011.81 feet. The elevation of the zero of the rod is 4,996.09 feet.

The following measurements were made by C. T. Prall and others during 1901:

List of discharge measurements of Duchesne River at Price road bridge, Utah.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1901.	*Feet.*	*Sec.-ft.*	1901.	*Feet.*	*Sec.-ft.*
April 6	5.18	264	August 16	5.37	354
April 12	5.23	296	August 24	5.55	443
April 19	5.39	335	August 30	5.53	422
April 27	6.52	1,110	September 6	5.38	361
May 4	6.70	1,267	September 13	5.25	301
May 10	7.20	1,746	September 20	5.20	272
May 18	8.75	5,167	September 27	5.27	310
May 27	8.52	4,160	October 4	5.23	294
June 4	7.35	2,099	October 11	5.32	326
June 12	6.83	1,499	October 18	5.28	309
June 19	6.57	1,298	October 25	5.29	295
June 24	6.48	1,178	November 1	5.42	362
June 29	6.15	913	November 8	5.32	306
July 6	5.88	673	November 15	5.30	299
July 12	5.96	756	November 22	5.33	318
July 19	5.57	456	November 29	5.28	304
July 26	5.77	575	December 6	5.33	332
August 2	5.41	411	December 13[a]	.....	.....
August 9	5.91	716			

[a] River frozen.

Daily gage height, in feet, of Duchesne River at Price road bridge, Utah, for 1901.

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	5.20	6.60	7.79	6.12	5.41	5.50	5.24	5.39	5.24
2	.....	5.21	6.83	7.63	6.10	5.45	5.47	5.22	5.39	5.24
3	.....	5.20	6.94	7.50	6.03	5.43	5.40	5.22	5.38	5.24
4	.....	5.20	6.74	7.33	5.98	5.43	5.39	5.23	5.37	5.24
5	.....	5.14	6.58	7.25	5.90	5.33	5.39	5.23	5.33	5.25
6	5.30	5.12	6.48	7.03	5.84	5.38	5.38	5.25	5.33	5.24
7	5.29	5.19	6.48	6.98	5.83	5.55	5.37	5.25	5.31	5.27
8	5.31	5.19	6.50	7.18	5.81	5.88	5.37	5.28	5.30	5.27
9	5.30	5.18	6.55	7.15	5.80	5.75	5.34	5.28	5.29	5.27
10	5.27	5.28	6.79	7.00	5.88	5.53	5.32	5.28	5.30	5.29
11	5.20	5.25	7.16	6.93	5.94	5.50	5.28	5.29	5.35	5.31
12	5.29	5.24	7.45	6.79	5.99	5.41	5.27	5.30	5.32	[a] 5.39
13	5.28	5.20	7.68	6.69	5.78	5.35	5.28	5.31	5.30	([a])
14	5.23	5.23	7.88	6.69	5.85	5.35	5.29	5.30	5.31	.....
15	5.21	5.38	7.95	6.64	5.81	5.30	5.20	5.31	5.30	.....
16	5.20	5.39	8.20	6.51	5.80	5.28	5.15	5.29	5.30	.....
17	5.23	5.39	8.63	6.50	5.65	5.45	5.17	5.28	5.30	.....
18	5.21	5.35	8.88	6.50	5.58	5.48	5.19	5.29	5.30	.....
19	5.24	5.35	9.28	6.53	5.53	5.55	5.18	5.28	5.30	.....
20	5.21	5.39	9.45	6.51	5.53	6.15	5.20	5.28	5.30	.....
21	5.21	5.53	9.20	6.47	5.53	5.95	5.19	5.28	5.29	.....
22	5.21	5.68	8.60	6.49	5.48	5.72	5.17	5.28	5.30	.....
23	5.21	5.95	8.03	6.53	5.48	5.62	5.15	5.29	5.27	.....
24	5.21	6.11	7.75	6.48	5.50	5.52	5.18	5.27	5.30	.....
25	5.21	6.12	7.88	6.44	5.50	5.50	5.19	5.27	5.29	.....
26	5.20	6.35	8.15	6.41	5.68	5.44	5.20	5.28	5.28	.....
27	5.20	6.49	8.65	6.27	5.77	5.49	5.24	5.34	5.27	.....
28	5.20	6.42	8.65	6.15	5.70	5.55	5.25	5.52	5.24	.....
29	5.20	6.26	8.55	6.14	5.63	5.53	5.25	5.56	5.24	.....
30	5.20	6.35	8.20	6.11	5.58	5.90	5.24	5.53	5.22	.....
31	5.20	.....	8.08	.....	5.50	5.64	.....	5.51	.....	.....

[a] Ice.

YAMPA RIVER, COLORADO.

Yampa River rises in the eastern part of Routt County, Colo., and flows in a general westerly direction through the entire county, and empties into Green River near the western boundary. The stream is

somewhat peculiar in its character, the upper branches having considerable fall and the water therefore flowing rapidly over shoals of gravel and rock and being thus easily taken out for utilization. This condition of affairs prevails as far down the stream as Hayden, where a broad and fertile valley is irrigated, the principal crops raised being hay for stock. From Hayden westerly the course of the stream changes. It flows for long distances, sometimes 20 miles or more, with but little fall, and then it breaks through some ridge of rock and the fall is great for comparatively short distances. For this reason the taking of water from the stream below Hayden is involved in greater difficulty than above and the ditches are therefore larger. Several large canals are, however, being constructed, among which the most important are those of Craig, Maybelle, and Lily Park. Below Lily Park the stream flows through a deep and rugged canyon, where no irrigation can be practiced, but above that point the amount of land that can and will eventually be irrigated is limited only by the amount of water available. Up to the present time but little impression has been made upon the early summer supply. The principal branches of the Yampa River are Elk River, heading in the vicinity of Hahns Peak; Elk Head Creek, Williams River, and Little Snake River. More or less irrigation is practiced upon all of these branches, and practically all of the waters of Fortification Creek and Elk Head Creek are used for irrigation. A large amount is, however, still available in the other branches and the project of taking a large supply of water from Elk River by means of a canal to the divide between Little Snake River and Yampa River has been contemplated. Axial Basin contains a considerable quantity of fertile land, which it is thought may perhaps be irrigated from the North Fork of White River. There are possibilities of developing power in the neighborhood of Steamboat Springs, which are being considered at the present time.

YAMPA RIVER AT CRAIG, COLO.

This station was established by A. L. Fellows May 25, 1901, at the wagon bridge about 1 mile southwest from Craig, Colo., this point being selected as the most suitable station on Yampa River. The gage consists of a vertical 2 by 4 inch timber fastened to the south abutment of the bridge on the downstream side, the rod being marked in feet and tenths vertically. The wagon bridge is marked every 10 feet. The channel is deep at this point and at low stages the current is sluggish, but measurements give good results, as the channel changes but little. The observer is Mr. H. Jones, of Craig, who visits the rod daily. Observations were kept up from May 25 to November 3, inclusive. The following measurements were made by A. L. Fellows during 1901:

May 25: Gage height, 7.10 feet; discharge, 6,890 second-feet.
November 3: Gage height, 2.20 feet; discharge, 180 second-feet.

Daily gage height, in feet, of Yampa River at Craig, Colo., for 1901.

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1		6.70	4.30	2.40	2.30	2.00	2.20
2		6.50	4.20	2.40	2.40	2.00	2.20
3		6.80	4.10	2.30	2.40	2.00	2.20
4		6.50	4.00	2.30	2.40	2.00	
5		6.30	3.80	2.30	2.30	2.00	
6		6.10	3.60	2.20	2.30	2.10	
7		6.00	3.50	2.30	2.40	2.10	
8		6.00	3.40	2.50	2.40	2.00	
9		6.20	3.40	2.60	2.30	2.10	
10		6.40	3.30	2.70	2.30	2.20	
11		6.30	3.40	2.60	2.30	2.20	
12		6.10	3.30	2.60	2.20	2.20	
13		5.90	3.30	3.50	2.20	2.30	
14		5.70	3.20	2.50	2.20	2.30	
15		5.90	3.10	2.40	2.20	2.30	
16		5.60	3.00	2.40	2.10	2.20	
17		5.50	2.90	2.30	2.10	2.20	
18		5.30	2.80	2.30	2.10	2.10	
19		5.40	2.70	2.40	2.00	2.20	
20		5.50	2.60	2.50	2.00	2.20	
21		5.50	2.60	2.60	2.00	2.10	
22		5.40	2.50	2.70	2.00	2.20	
23		5.40	2.50	2.70	2.00	2.20	
24		5.30	2.50	2.60	2.00	2.20	
25	7.10	5.30	2.50	2.60	2.00	2.20	
26	6.90	5.20	2.60	2.50	2.00	2.20	
27	7.20	5.00	2.60	2.40	2.00	2.10	
28	7.10	4.90	2.70	2.40	2.00	2.10	
29	7.00	4.70	2.60	2.30	2.00	2.10	
30	6.90	4.50	2.50	2.30	2.00	2.20	
31	6.80		2.50	2.30		2.20	

WHITE RIVER, COLORADO.

The principal branches of White River rise in the White River Plateau, a well-forested tract in the White River Forest Reserve. A number of lakes, among which are Oyster Lake, Marvine Lake, Trappers Lake, and Deep Lake furnish important reservoir sites, if such are ever needed. The need for these as yet, however, has not arisen. The stream flows in a generally westerly direction, particularly in Rio Blanco County, and discharges into Green River in Utah. Areas of considerable extent are irrigated, particularly in the vicinity of Meeker, and at points above Meeker. Other possibilities for extended irrigation exist both in the vicinity of Meeker and upon the mesas adjoining the stream; particularly along its lower courses. It is also thought possible that a considerable amount of water may be taken from the North Fork of White River for the irrigation of Axial Basin in Routt County. If the demand should arise, power may be developed probably to any extent desired upon the upper branches of the stream. The principal town of the White River Valley is Meeker. The crops raised are principally grain and hay, as the principal industry is stock raising.

WHITE RIVER AT MEEKER, COLO.

This station was established by A. L. Fellows, May 24, 1901, at a point about one-fourth of a mile above the town of Meeker, there

being at this point a wagon bridge crossing the stream upon the ranch of L. F. Van Cleave, favorably situated for the purpose. The gage rod consists of a vertical 2 by 4 inch timber nailed to the left abutment of the bridge on the downstream side. The bridge is marked every 5 feet. The initial point for soundings is at the rod, at the left or south end of the bridge. The banks are sufficiently high so as not to be liable to overflow; the channel is of rock and gravel, and seems permanent in its nature. Measurements are made from the lower side of the wagon bridge. The observer is L. F. Van Cleave, who visits the rod twice each day. Only two gagings were made in 1901, both by A. L. Fellows, as follows:

May 24: Gage height, 5.60 feet; discharge, 2.605 second-feet.
October 28: Gage height, 3.60 feet; discharge, 397 second-feet.

Daily gage height, in feet, of White River at Meeker, Colo., for 1901.

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1		5.35	4.45	3.50	3.80	3.50	3.60
2		5.35	4.45	3.50	3.70	3.50	
3		5.45	4.35	3.50	3.65	3.50	
4		5.20	4.30	3.50	3.75	3.50	
5		5.20	4.25	3.50	3.60	3.50	
6		5.05	4.25	3.60	3.60	3.50	
7		5.10	4.05	3.80	3.60	3.65	
8		5.15	4.05	3.75	3.60	3.70	
9		5.50	4.05	3.85	3.60	3.60	
10		5.50	4.05	3.70	3.60	3.60	
11		5.55	4.00	3.70	3.60	3.60	
12		5.30	4.00	3.70	3.60	3.60	
13		5.15	3.95	3.65	3.50	3.60	
14		5.15	3.95	3.60	3.50	3.60	
15		5.10	3.90	3.60	3.50	3.60	
16		4.95	3.90	3.60	3.50	3.60	
17		4.90	3.85	3.65	3.50	3.60	
18		4.95	3.80	3.60	3.50	3.60	
19		4.95	3.80	3.60	3.50	3.60	
20		5.05	3.80	3.75	3.50	3.60	
21		5.05	3.70	3.75	3.50	3.55	
22	6.50	5.15	3.70	3.70	3.50	3.55	
23	5.80	5.10	3.70	3.70	3.50	3.55	
24	5.70	5.10	3.85	3.70	3.50	3.55	
25	5.70	5.05	3.80	3.70	3.50	3.55	
26	5.65	4.95	3.85	3.70	3.50	3.55	
27	5.75	4.85	3.85	3.70	3.50	3.55	
28	5.65	4.75	3.80	3.60	3.50	3.60	
29	5.65	4.65	3.70	3.70	3.50	3.60	
30	5.45	4.55	3.70	3.85	3.50	3.60	
31	5.50		3.60	3.80		3.60	

GRAND RIVER AT GLENWOOD SPRINGS, COLO.

This station was established May 12, 1899, at the request of the Denver and Rio Grande Railroad Company. It is situated at the railroad bridge one-fourth of a mile west of the station and just above the mouth of Roaring Fork. A description of the station was published in Water-Supply Paper No. 50, page 375. Results of measurements for 1899 and 1900 will be found in the Twenty-second Annual Report, Part IV, page 389.

Daily gage height, in feet, of Grand River at Glenwood Springs, Colo., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.80	3.15	3.30	3.15	6.85	8.60	7.40	4.50	4.10	3.40	3.50	3.40
2	2.75	3.10	3.35	3.25	7.30	8.25	7.20	4.35	4.10	3.40	3.50	3.40
3	2.75	3.10	3.45	3.20	7.40	8.15	7.05	4.30	4.00	3.40	3.50	3.50
4	2.95	3.20	3.45	3.30	7.00	8.10	6.90	4.20	3.90	3.40	3.50	3.50
5	3.05	3.20	3.45	3.45	6.55	7.80	6.65	4.45	3.90	3.40	3.40	3.50
6	2.95	3.10	3.45	3.50	6.40	7.70	6.40	4.60	3.90	3.40	3.40	3.50
7	3.05	3.20	3.45	3.45	6.25	7.35	6.30	5.20	3.90	3.40	3.40	3.50
8	3.20	3.15	3.55	3.40	6.20	7.55	6.25	4.95	3.80	3.40	3.40	3.45
9	3.30	3.10	3.45	3.50	6.30	7.90	6.00	5.35	3.75	3.55	3.40	3.20
10	3.15	3.10	3.45	3.65	6.55	8.20	6.05	5.30	3.70	3.55	3.40	3.20
11	3.15	3.10	3.45	3.60	6.90	8.20	6.10	4.95	3.70	3.50	3.40	3.20
12	3.10	3.05	3.35	3.60	7.30	8.05	6.10	4.80	3.65	3.50	3.40	3.35
13	3.25	2.95	3.35	3.50	7.70	7.70	6.00	4.55	3.60	3.50	3.40	3.15
14	3.20	2.95	3.35	3.60	7.95	7.60	5.80	4.35	3.60	3.50	3.35	2.95
15	3.10	3.10	3.35	3.65	8.05	7.50	6.65	4.30	3.60	3.50	3.30	3.00
16	3.05	3.10	3.35	3.70	8.20	7.40	5.45	4.25	3.55	3.50	3.35	3.00
17	3.05	3.20	3.40	3.60	8.40	7.15	5.30	4.20	3.60	3.50	3.35	3.15
18	3.05	3.25	3.35	3.75	8.85	7.10	5.15	4.20	3.50	3.50	3.45	3.35
19	3.00	3.25	3.35	3.65	9.35	7.10	5.10	4.30	3.50	3.50	3.40	3.30
20	3.00	3.30	3.25	3.75	9.85	7.20	5.00	4.20	3.50	3.50	3.40	3.20
21	3.15	3.55	3.40	4.00	10.10	7.60	5.00	4.30	3.50	3.50	3.40	3.05
22	3.20	3.30	3.30	4.30	10.15	7.90	4.85	4.30	3.50	3.50	3.40	3.20
23	3.20	3.30	3.25	4.60	9.75	8.00	4.80	4.20	3.40	3.50	3.40	3.25
24	3.10	3.25	3.25	4.80	8.95	8.20	4.80	4.20	3.40	3.45	3.40	3.35
25	3.10	3.30	3.20	5.00	8.60	8.20	4.80	4.20	3.40	3.45	3.50	3.35
26	3.20	3.15	3.30	5.45	8.70	8.00	4.85	4.10	3.40	3.50	3.50	3.20
27	2.95	3.25	3.25	5.80	8.95	7.80	4.90	4.00	3.35	3.50	3.50	3.25
28	3.00	3.30	3.20	5.90	9.35	7.55	4.80	4.00	3.40	3.50	3.40	3.15
29	3.20	.....	3.20	6.00	9.35	7.50	4.70	4.00	3.40	3.50	3.35	3.00
30	3.10	.....	3.20	6.40	8.90	7.40	4.65	4.00	3.40	3.50	3.40	3.05
31	2.95	.....	3.15	.....	8.60	.....	4.60	4.10	.....	3.50	.....	3.15

GUNNISON RIVER AT IOLA, COLO.

The Iola station was established in March, 1900, for the purpose of determining the amount of water available for the irrigation project of Uncompahgre Valley. It is described in Water-Supply Paper No. 50, page 378. The observer is A. Pomel, postmaster at Iola, who telegraphs the gage height daily to the local forecast official of the United States Weather Bureau at Denver, who has it printed in the morning papers. The position of the gage was verified April 11. Results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 390. During 1901 the following measurements were made by A. L. Fellows at the Iola station:

April 11: Gage height, 2.16 feet; discharge, 388 second-feet.
May 7: Gage height, 4.80 feet; discharge, 4,005 second-feet.
July 29: Gage height, 2.70 feet; discharge, 836 second feet.

Daily gage height, in feet, of Gunnison River at Iola, Colo., for 1901.

Day.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	2.20	4.00	4.60	3.70	2.60	2.50	2.00	2.10
2	2.20	4.20	4.30	3.60	2.60	2.40	2.00	2.10
3	2.20	3.90	4.30	3.60	2.50	2.40	2.00	2.10
4	2.20	3.70	4.20	3.60	2.50	2.40	2.00	2.10
5	2.20	3.60	4.20	3.40	2.50	2.40	2.00	2.00
6	2.20	3.70	4.10	3.20	2.60	2.30	2.00	2.00
7	2.20	3.60	4.10	3.10	2.70	2.30	2.00	2.00
8	2.20	3.70	4.30	3.00	2.80	2.30	2.00	2.00
9	2.20	3.70	4.60	3.00	2.90	2.20	2.00	2.00
10	2.20	3.80	4.60	2.90	2.70	2.20	2.10	2.00
11	2.20	4.00	4.50	2.90	2.60	2.20	2.20	2.00
12	2.20	4.20	4.30	2.90	2.60	2.20	2.10	2.00
13	2.20	4.40	4.10	2.80	2.50	2.10	2.10	2.00
14	2.30	4.60	3.90	2.80	2.40	2.10	2.10	2.00
15	2.40	4,50	3.90	2.80	2.40	2.10	2.10	2.00
16	2.50	4.60	3.80	2.80	2.40	2.10	2.10	2.00
17	2.50	4.80	3.80	2,70	2.40	2.10	2.00	2.00
18	2.40	5.00	3.80	2.70	2.50	2.10	2.00	2.00
19	2.50	5.30	3.90	2.60	2.50	2.10	2.00	2.00
20	2.60	5.70	4.00	2.60	2.60	2.00	2.00	2.00
21	2.70	5.60	4.00	2.60	2.50	2.00	2.00	2.00
22	2.80	5.60	4.10	2.60	2.50	2.00	2.00	2.00
23	2.90	4.80	4.10	2.50	2.40	2.00	2.00	2.00
24	3.00	4.80	4.20	2.50	2.40	2.00	2.00	2.00
25	3.30	4.80	4.10	2.60	2.40	2.00	2.00	2.00
26	3.70	4.90	3.90	2.80	2.40	2.00	2.00	2.00
27	3.70	5.00	3.80	2.80	2.30	2.00	2.00	2.00
28	3.60	5.00	3.80	2.70	2.30	2.00	2.00	2.00
29	3.70	5.00	3.70	2.70	2.30	2.00	2.10	2.00
30	3.80	4.80	3.70	2.70	2.40	2.00	2.10	2.10
31	.....	4.80	.....	2.70	2.50	.....	2.10	.....

NOTE.—River gorged with ice April 2 to April 7, inclusive.

GUNNISON RIVER AT WHITEWATER, COLO.

This station was established by A. L. Fellows May 21, 1901, at a new wagon bridge constructed by the State of Colorado at a point about half a mile above the railroad station at Whitewater, on the Denver and Rio Grande Railroad. It is intended that this station should take the place of the one formerly maintained on the Gunnison at Grand Junction. The latter station was abandoned on account of inaccuracies that could not be overcome. The latter were mainly due to the fact that high stages of water in the Grand River affected the gage rod in the Gunnison, and that the stream bed was partially filled with great bowlders, making accurate gagings impossible. Records were kept for the period from May 19 to July 6, inclusive, by Mr. James Page, station agent of the Denver and Rio Grande Railroad at Whitewater. Only one gaging was made, however, that of May 21, by A. L. Fellows. The record book was destroyed by fire, which burned the station house July 10, and the maintenance of the station was not resumed. During the period covered the gage rod used was one set up near the railroad station by the railroad company, no gage being placed at the bridge. The records, therefore, simply show relative heights of the river, without furnishing information concerning the actual discharge except at the unusually high stage measured on May 21, when the flow was 20,176 second-feet for a gage heigh of 7.20 feet.

Daily gage height, in feet, of Gunnison River at Whitewater, Colo., for 1901.

Day.	May.	June.	July.	Day.	May.	June.	July.	Day.	May.	June.	July.
1		4.65	2.70	12		3.30		23	5.90	2.90	
2		4.45	2.60	13		3.05		24	5.30	2.75	
3		4.20	2.45	14		3.30		25	4.80	2.75	
4		3.80	2.55	15		3.10		26	5.05	2.85	
5		3.65	2.60	16		3.00		27	5.20	3.00	
6		3.55	2.60	17		2.90		28	5.25	3.00	
7		3.50		18		2.75		29	5.25	2.85	
8		3.65		19	6.70	2.65		30	5.05	2.75	
9		3.80		20	7.00	2.75		31	4.75		
10		3.65		21	7.20	2.90					
11		3.55		22	6.70	3.00					

DOLORES RIVER AT DOLORES, COLO.

The gaging station is about a half mile above the Rio Grande Southern Railroad station at Dolores. It is described in Water-Supply Paper No. 50, page 380. The results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 391. During 1901 one measurement was made by A. L. Fellows, on April 15, the discharge being 558 second-feet for a gage height of 3.60 feet. The gage was verified by him on that date.

Daily gage height, in feet, of Dolores River at Dolores, Colo., for 1901.

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.
1	3.20	2.80	5.65	4.85	3.70	3.05	3.05	2.40
2	3.20	2.80	5.65	4.80	3.70	3.05	2.95	2.40
3	3.40	3.05	4.85	4.75	3.70	3.15	2.90	2.40
4	3.35	2.95	4.75	4.60	3.55	3.15	2.80	2.40
5	3.30	2.95	4.65	4.60	3.45	3.25	2.75	2.40
6	3.30	3.00	5.15	4.55	3.35	3.15	2.75	2.50
7	3.05	3.10	5.55	4.75	3.15	3.10	2.65	2.50
8	3.10	3.00	5.35	4.95	3.15	3.15	2.70	2.50
9	3.20	3.10	5.20	4.85	3.15	3.05	2.65	2.50
10	2.90	3.10	5.25	4.80	3.10	3.05	2.60	2.60
11	2.90	3.10	5.45	4.75	3.05	2.95	2.55	2.60
12	2.90	3.15	5.25	4.70	3.15	2.90	2.50	2.60
13	2.90	3.30	5.00	4.60	3.05	2.85	2.45	2.60
14	2.80	3.60	4.95	4.50	3.05	2.85	2.40	2.60
15	2.80	3.60	5.20	4.40	3.05	2.85	2.40	2.60
16	2.80	3.60	5.65	4.30	3.05	2.85	2.40	2.60
17	2.85	3.60	5.75	4.20	3.05	2.85	2.35	2.60
18	2.85	3.80	5.85	4.20	3.05	2.85	2.35	2.55
19	3.00	4.20	5.75	4.20	3.00	2.95	2.35	2.55
20	2.95	4.50	6.10	4.10	2.95	2.90	2.35	2.50
21	2.95	4.50	5.95	4.15	2.95	3.00	2.35	2.50
22	3.00	4.75	6.10	4.20	3.00	2.90	2.35	2.50
23	3.10	4.95	5.95	4.25	3.05	2.95	2.35	2.50
24	2.95	5.15	5.80	4.35	3.20	3.10	2.35	2.50
25	3.00	5.35	5.35	4.30	3.05	3.00	2.35	2.50
26	3.00	5.60	5.25	4.25	3.00	2.95	2.40	2.40
27	2.95	5.60	5.20	4.20	3.00	2.95	2.40	2.40
28	2.95	5.10	5.20	4.15	3.00	3.05	2.40	2.40
29	2.90	5.30	5.20	4.05	3.05	3.10	2.40	2.40
30	2.80	5.50	5.20	3.95	3.15	3.10	2.40	2.40
31	2.80		5.10		3.15	3.15		2.35

LOS PINOS RIVER AT IGNACIO, COLO.

The station was established April 22, 1899, at the request of the Commissioner of Indian Affairs, for the purpose of ascertaining the quantity of water available for irrigation along the stream. The

station is an important one, as all of the waters of the stream will undoubtedly be used for irrigation before many years. On April 7 an iron bench-mark post was set 30 feet northwest from the northwest corner of the bridge, its top being 7.64 feet above the zero of the gage. The observer is Mr. John Wesch, the clerk at the agency. A description of the station was published in Water-Supply Paper No. 50, page 382. The results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 393. During 1901 the following measurements were made by A. L. Fellows:

April 17: Gage height, 3.00 feet; discharge, 264 second-feet.
August 5: Gage height, 2.55 feet; discharge, 110 second-feet.

Daily gage height, in feet, of Los Pinos River at Ignacio, Colo., for 1901.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Day.	Apr.	May.	June.	July.	Aug.	Sept.
1	2.55	4.30	3.95	3.40	2.60	3.00	17	3.05	3.85	3.75	2.65	2.50	2.60
2	2.60	4.50	3.90	3.35	2.60	2.85	18	3.00	4.65	3.85	2.65	2.50	2.55
3	2.68	4.05	3.85	3.35	2.55	2.80	19	3.05	5.05	3.70	2.55	3.85	2.50
4	2.80	3.90	3.90	3.20	2.50	3.45	20	3.35	4.95	3.70	2.50	3.60	2.50
5	2.70	3.85	3.80	3.20	2.65	3.15	21	3.65	4.85	3.65	2.50	3.25	2.50
6	2.75	3.90	3.80	3.10	2.75	3.05	22	3.75	4.80	3.60	2.50	3.05	2.50
7	2.75	3.85	3.65	2.95	2.70	2.90	23	3.75	4.55	3.60	2.50	2.85	2.45
8	2.75	3.80	3.75	2.95	2.70	2.85	24	3.80	4.45	3.55	2.45	2.80	2.40
9	2.75	3.75	3.80	2.85	2.70	2.80	25	3.90	4.25	3.65	2.45	2.80	2.45
10	2.65	3.70	3.75	2.95	2.60	2.80	26	4.40	4.30	3.75	2.45	2.75	2.45
11	2.65	3.85	3.80	2.85	2.60	2.75	27	4.15	4.20	3.70	2.65	2.75	.....
12	2.75	3.90	3.90	2.80	2.60	2.70	28	3.95	4.15	3.65	2.75	2.75	.....
13	2.78	3.85	3.85	2.85	2.55	2.70	29	3.90	4.15	3.60	2.70	2.70	.....
14	2.95	4.05	3.80	2.75	2.50	2.65	30	4.25	4.10	3.55	2.70	2.75	.....
15	3.00	3.90	3.80	2.75	2.50	2.60	31	.....	4.05	.....	2.65	2.70	.....
16	3.10	3.90	3.80	2.75	2.50	2.60							

FLORIDA RIVER NEAR DURANGO, COLO.

This station, as described in Water-Supply Paper No. 38, page 311, was maintained from April 1 to June 30, 1901. The observer is Mrs. Annie Stewart, who lives near by. The Stewart ranch is located about 6½ miles east of Durango and is reached by driving. The gage rod consists of a vertical 4-inch strip 7½ feet long, marked vertically in feet and tenths and spiked to the east abutment of the bridge. The bench mark was established April 15, 1901, and consists of a spike in an 8-inch cottonwood stump, 50 feet south from and 5.86 feet above the zero of the rod. Gagings are made at the wagon bridge, excepting at low water, when they may be made by wading. Information derived at this point is of importance, as it is desired that the excess water of this stream shall be made available by means of storage reservoirs in the upper part of this drainage basin. Much valuable land can be irrigated if this water is properly conserved.

During 1901 one measurement was made by A. L. Fellows, on April 16, when the flow was found to be 53 second-feet, the gage height being 1.48 feet.

Daily gage height, in feet, of Florida River near Durango, Colo., for 1901.

Day.	Apr.	May.	June.	Day.	Apr.	May.	June.	Day.	Apr.	May.	June.
1	1.05	2.80	2.40	12	1.20	2.65	2.15	23	2.05	3.05	1.75
2	1.05	2.80	2.30	13	1.30	2.55	2.15	24	2.20	3.15	1.80
3	1.10	2.55	2.20	14	1.40	2.75	1.85	25	2.30	3.05	1.65
4	1.20	2.25	2.20	15	1.40	2.55	1.90	26	2.65	2.95	1.75
5	1.05	2.35	2.20	16	1.45	2.50	1.95	27	2.65	3.15	1.50
6	1.15	2.30	2.20	17	1.40	2.85	1.85	28	2.60	2.85	1.40
7	1.20	2.40	2.45	18	1.40	3.10	1.90	29	2.35	2.75	1.35
8	1.20	2.40	2.45	19	1.50	3.50	1.90	30	2.65	2.75	1.35
9	1.20	2.45	2.60	20	1.65	3.75	1.90	31		2.65	
10	1.20	2.50	2.45	21	1.90	3.45	1.85				
11	1.20	2.55	2.45	22	2.00	3.35	1.70				

ANIMAS RIVER AT DURANGO, COLO.

The station was established June 20, 1895, and has been maintained during the greater part of each year since. No records were kept after May 4, 1901. The position of the gage was verified April 17. A description of the station was published in Water-Supply Paper No. 50, page 383. The results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 394. During 1901 the following measurements were made by A. L. Fellows:

April 17: Gage height, 7.00 feet; discharge, 404 second-feet.
August 5: Gage height, 6.80 feet; discharge, 381 second-feet.

Daily gage height, in feet, of Animas River at Durango, Colo., for 1901.

Day.	Mar.	Apr.	May.	Day.	Mar.	Apr.	May.	Day.	Mar.	Apr.	May.
1		6.50	9.90	11		6.60		21		8.35	
2		6.50	9.85	12		6.60		22		8.65	
3		6.50	9.10	13		6.60		23		8.45	
4		6.50	8.70	14		6.70		24		8.35	
5		6.50		15		7.20		25		8.65	
6		6.60		16		7.00		26		9.35	
7		6.60		17		6.90		27		9.30	
8		6.60		18		6.80		28		9.05	
9		6.60		19		6.80		29		9.00	
10		6.60		20		7.40		30	6.50	9.50	

MANCOS RIVER AT MANCOS, COLO.

The station at Mancos was established April 9, 1898, for the purpose of determining the amount of water going to waste during high-water periods. During 1901 the bed of the stream shifted to such an extent that a rating table for that year is impossible. The position of the gage was verified April 13, 1901. A description of the station was published in Water-Supply Paper No. 50, page 384. During 1901 the following measurements were made by A. L. Fellows:

April 13: Gage height, 2 feet; discharge, 49 second-feet.
August 8: Gage height, 2.28 feet; discharge, 17 second-feet.

Daily gage height, in feet, of Mancos River at Mancos, Colo., for 1901.

Day.	Apr.	May.	June.	Day.	Apr.	May.	June.	Day.	Apr.	May.	June.
1		4.10	3.70	12		4.00	2.70	23	3.45	4.00	
2		4.10	3.60	13		4.10	2.60	24	3.60	4.00	
3		4.10	3.50	14		4.10	2.40	25	3.60	3.90	
4		4.20	3.50	15	2.30	4.10	2.20	26	3.95	3.90	
5		4.20	3.50	16	2.35	4.05	2.00	27	4.10	3.80	
6		4.20	3.40	17	2.30	3.90	2.00	28	4.10	3.80	
7		4.20	3.00	18	2.40	3.90	2.00	29	4.10	3.70	
8		4.10	2.90	19	2.60	3.90	2.20	30	4.10	3.70	
9		4.10	2.90	20	3.25	3.90	2.25	31		3.70	
10		4.10	2.80	21	3.35	4.00					
11		4.00	2.70	22	3.40	4.00					

MISCELLANEOUS DISCHARGE MEASUREMENTS IN COLORADO RIVER BASIN IN COLORADO.

Date.	Stream.	Locality.	Hydrographer.	Discharge.
1901.				*Sec.-ft.*
Nov. 12	North Fork of Yampa River.	Yampa	A. L. Fellows	4
Nov. 12	South Fork of Yampa River.	do	do	3
Nov. 12	Yampa River	do	do	10
Nov. 11	Hunt Creek	do	do	6
Nov. 11	Oak Creek	Pinnacle	do	3
Nov. 10	Trout Creek	do	do	9
Nov. 10	Fish Creek	Dunkley	do	5
Nov. 10	Sage Creek	Hayden	do	3
Nov. 9	Elk Head Creek	Craig	do	7
Nov. 9	Fortification Creek	do	do	3
May 25	Williams Fork	Hamilton	do	1,214
Nov. 3	do	do	do	43
May 25	Morapes Creek	do	do	41
Nov. 3	do	do	do	1
May 26	Milk Creek	Axial	do	138
Oct. 28	do	do	do	4
Nov. 13	Troublesome Creek	Troublesome Creek	do	36
Nov. 13	Muddy Creek	Kremmling	do	12
Nov. 13	Pass Creek	do	do	5
Nov. 13	Blue River	do	do	180
Nov. 12	Rock Creek	Toponas	do	8
Nov. 12	Little Rock Creek	do	do	3
Oct. 24	Plateau Creek	Colbran	do	24
May 22	Grand River	Grand Junction	do	31,507
Oct. 23	Surface Creek	Cedaredge	do	15
Oct. 22	Gunnison River	Near Delta	do	605
May 20	Uncompahgre River	Montrose	do	1,083
Oct. 21	do	Delta	do	13
Apr. 15	Lost Canyon Creek	Dolores	do	211
Aug. 9	Dolores River	Rico	do	96

GILA RIVER AT SAN CARLOS, ARIZ.

This station was established by C. C. Babb on July 11, 1899, in connection with an investigation of Gila River with reference to a supply of water for the Gila River Indian Reservation and arid lands in vicinity. Results of this investigation were published in Water-Supply Paper No. 33, entitled Storage of Water on Gila River, Arizona, by J. B. Lippincott. The station is a half mile south of the Indian agency at San Carlos, below the mouth of San Carlos Creek. It is described in Water-Supply Paper No. 50, page 385. Results of measurements for 1900 will be found in the Twenty-second Annual Report,

Part IV, page 397. During 1901 the following measurements were made by Stephen Janus and A. P. Davis:

List of discharge measurements of Gila River at San Carlos, Ariz.

Date.	Hydrographer.	Gage height.	Discharge.	Date.	Hydrographer.	Gage height.	Discharge.
1901.		*Feet.*	*Sec.-ft.*	1901.		*Feet.*	*Sec.-ft.*
Jan. 27	Stephen Janus	2.35	2.20	July 27	Stephen Janus	3.01	1,223.00
Jan. 29	do	3.00	9.57	July 29	do	3.70	2,087.80
Mar. 28	do	2.20	1.57	Aug. 11	do	2.90	836.40
May 16	A. P. Davis	1.59	7.60	Aug. 17	do	2.20	403.50
May 25	Stephen Janus	1.50	4.89	Aug. 28	do	1.50	87.50
June 1	do	1.50	7.08	Sept. 10	do	6.20	8,180.85
June 8	do	1.45	4.12	Sept. 11	do	3.00	1,260.00
June 15	do	1.30	4.45	Sept. 14	do	2.00	251.72
June 22	do	1.00	2.14	Sept. 17	do	1.80	95.70
June 29	do	1.00	.52	Oct. 9	do	1.60	50.47

Daily gage height, in feet, of Gila River at San Carlos, Ariz., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.75	2.60	2.90	2.20	1.50	1.50	[a]	2.80	1.30	1.40	2.20	2.20
2	1.75	3.00	2.80	2.15	1.50	1.50	[a]	2.80	1.30	1.40	2.20	2.20
3	1.75	3.00	2.70	2.15	1.50	1.50	[a]	2.60	1.30	1.40	2.20	2.20
4	1.75	3.00	2.60	2.15	1.50	1.50	[a]	2.65	1.30	1.30	2.20	2.20
5	1.80	2.80	2.60	2.10	1.50	1.50	[a]	2.40	1.30	1.30	2.20	2.15
6	1.80	2.80	2.60	2.10	1.50	1.50	[a]	2.40	1.30	1.30	2.20	2.15
7	1.80	2.80	2.60	2.10	1.50	1.50	[a]	2.30	1.30	1.45	2.20	2.10
8	1.80	3.20	2.80	2.00	1.50	1.48	[a]	2.25	1.30	1.55	2.20	2.10
9	1.70	3.20	3.10	2.00	1.50	1.45	[a]	2.65	1.30	1.45	2.20	2.10
10	1.80	3.20	3.10	2.00	1.50	1.40	[a]	2.85	4.43	1.40	2.20	2.10
11	1.70	3.70	3.00	2.00	1.50	1.40	[a]	2.95	3.00	1.35	2.20	2.10
12	1.70	3.50	2.80	2.00	1.50	1.40	[a]	3.55	3.20	1.30	2.20	2.10
13	1.70	3.20	2.70	1.90	1.50	1.40	[a]	3.15	2.35	1.30	2.20	2.10
14	1.80	3.20	2.60	1.90	1.50	1.30	[b]	3.15	1.98	1.30	2.20	2.05
15	1.80	3.10	2.60	1.80	1.50	1.30	[b]	2.50	1.85	1.30	2.20	2.05
16	1.80	3.00	2.60	1.80	1.59	1.30	[b]	2.35	1.75	1.30	2.20	2.05
17	1.80	3.00	2.60	1.80	1.59	1.25	[b]	2.20	1.73	1.30	2.75	2.05
18	1.80	2.90	2.50	1.80	1.58	1.20	[b]	2.20	1.70	1.30	2.55	2.05
19	1.80	3.00	2.50	1.80	1.55	1.20	[b]	2.20	1.70	1.30	2.40	2.05
20	1.80	3.00	2.50	1.80	1.55	1.15	[b]	2.05	1.70	1.30	2.40	2.05
21	1.80	3.20	2.40	1.80	1.50	1.00	[b]	2.00	1.68	1.30	2.40	2.05
22	1.80	3.20	2.40	1.80	1.50	1.00	[b]	1.95	1.55	1.30	2.35	2.05
23	1.80	3.30	2.30	1.80	1.50	1.00	[b]	1.85	1.45	1.30	2.30	2.05
24	1.80	3.30	2.30	1.70	1.50	1.00	2.50	1.65	1.40	1.30	2.30	2.05
25	1.90	3.50	2.30	1.70	1.50	1.00	2.00	1.60	1.40	2.40	2.30	2.05
26	2.00	3.30	2.30	1.60	1.55	1.00	2.20	1.60	1.40	2.45	2.20	2.05
27	2.35	3.00	2.20	1.50	1.50	1.00	3.10	1.55	1.40	2.25	2.20	2.05
28	2.50	2.90	2.20	1.50	1.50	1.00	3.75	1.50	1.40	2.00	2.20	2.05
29	3.15	.....	2.20	1.50	1.50	1.00	3.70	1.50	1.40	2.00	2.20	2.00
30	2.90	.....	2.20	1.50	1.50	.....	4.43	1.45	1.40	1.90	2.20	2.00
31	2.70	.....	2.20	.....	1.50	.....	3.00	1.40	.....	2.10	.....	2.00

[a] No current, water standing in pools. Runs a little at night.
[b] No current, water standing in pools.

SALT RIVER AT THE RESERVOIR SITE, ARIZONA.

The station, established February 7, 1901, by H. G. Heisler, is 15 miles west of Livingston, Ariz. The rod is on the left bank of the river at the upper end of the gorge. Gagings are made from a trav-

eling car suspended from a cable. The following measurements were made by W. Richins during 1901:

List of discharge measurements of Salt River at the reservoir site, Arizona.

Date	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1901.	*Feet.*	*Sec.-ft.*	1901.	*Feet.*	*Sec.-ft.*
July 8	6.76	119.72	September 14	7.10	215.69
July 10	6.70	99.71	September 16	7.10	201.31
July 11	6.60	80.16	September 27	6.82	129.74
July 13	6.64	83.00	October 1	6.82	135.80
July 20	6.59	74.33	October 5	6.80	122.29
July 23	7.02	201.28	October 8	6.91	163.36
July 25	7.40	331.55	October 12	6.90	155.97
July 27	8.02	885.65	October 15	6.89	153.23
July 30	10.15	4,402.28	October 18	6.89	157.01
Do	10.35	4,433.83	October 23	6.91	160.86
August 3	8.00	859.70	October 26	6.95	179.58
August 5	7.80	604.85	October 29	6.97	175.72
August 10	7.50	389.46	November 1	7.07	211.65
August 15	7.70	557.50	November 4	7.01	184.24
August 17	7.45	362.90	November 8	7.01	179.20
August 20	7.27	285.57	November 23	7.05	187.96
August 24	7.25	284.60	December 2	7.03	180.97
August 28	7.10	209.36	December 6	7.05	189.64
August 31	7.21	250.64	December 9	7.05	189.98
September 3	7.16	252.78	December 13	7.03	179.61
September 7	6.93	169.59	December 16	7.04	180.25
September 10	7.16	195.36	December 20	7.02	172.92
September 12	7.16	224.51			

Daily gage height, in feet, of Salt River at the reservoir site, Arizona, for 1901.

Day.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	8.50	7.95	8.30	7.69	6.88	7.85	7.14	6.82	7.06	7.04
2	.....	8.50	7.95	8.27	7.68	6.86	7.80	7.16	6.81	7.04	7.04
3	.....	8.50	7.93	8.35	7.64	6.83	7.90	7.17	6.80	7.03	7.04
4	.....	8.70	7.87	8.28	7.61	6.80	7.75	7.10	6.79	7.01	7.05
5	.....	8.75	7.90	8.25	7.57	6.79	8.04	7.02	6.80	7.02	7.05
6	.....	8.60	7.95	8.18	7.50	6.78	7.79	6.97	6.82	7.02	7.05
7	2.85	8.60	7.95	8.05	7.49	6.74	7.78	6.92	6.88	7.01	7.05
8	2.55	8.60	7.95	8.00	7.45	6.78	7.64	6.90	6.91	7.01	7.04
9	2.40	9.30	8.02	8.01	7.42	6.70	7.73	6.89	6.90	7.01	7.05
10	2.35	9.80	8.07	8.00	7.38	6.68	7.53	6.92	6.90	7.01	7.05
11	3.40	9.40	8.08	7.96	7.36	6.67	8.20	7.38	6.90	7.02	7.05
12	3.10	8.75	8.07	7.95	7.34	6.67	9.05	7.25	6.90	7.02	7.03
13	2.82	8.70	8.03	7.96	7.28	6.64	8.10	7.08	6.90	7.07	7.03
14	2.68	8.60	8.00	7.94	7.27	6.62	8.10	7.10	6.89	7.06	7.04
15	2.05	8.40	8.02	7.92	7.25	6.61	7.75	7.12	6.89	7.10	7.04
16	1.85	8.40	8.15	7.90	7.21	6.59	7.55	7.09	6.89	7.10	7.02
17	1.82	8.30	8.35	7.85	7.20	6.58	7.47	7.03	6.89	7.10	7.01
18	1.70	8.25	8.37	7.80	7.16	6.59	7.37	7.88	6.89	7.08	7.00
19	3.15	8.20	8.30	7.78	7.14	6.58	7.30	7.83	6.89	7.08	7.00
20	3.45	8.20	8.27	7.78	7.12	6.65	7.28	7.82	6.88	7.08	7.02
21	3.00	8.25	8.28	7.80	7.09	6.61	7.33	7.79	6.88	7.07	7.00
22	2.85	8.20	8.35	7.80	7.07	6.67	7.37	7.77	6.91	7.05	7.01
23	3.10	8.20	8.45	7.80	7.05	6.92	7.66	7.75	6.91	7.05	7.03
24	3.10	8.15	8.45	7.73	7.03	7.11	7.25	7.73	6.92	7.05	7.04
25	2.70	8.15	8.50	7.69	7.01	7.43	7.18	7.72	6.94	7.06	7.03
26	2.50	8.15	8.57	7.65	7.00	7.33	7.13	7.33	6.95	7.05	7.04
27	2.10	8.05	8.55	7.67	6.97	7.75	7.08	6.81	6.95	7.05	7.04
28	1.75	8.00	8.48	7.62	6.95	8.28	7.10	6.81	6.97	7.04	7.04
29	.....	8.00	8.42	7.67	6.90	8.13	7.20	6.81	6.98	7.05	7.04
30	.....	7.95	8.33	7.69	6.89	9.85	7.23	6.81	7.03	7.04	7.02
31	.....	7.95	.....	7.68	.....	8.40	7.20	.....	7.10	.....	7.01

TONTO CREEK NEAR LIVINGSTON, ARIZ.

The station, established April 1, 1901, by H. G. Heisler, is 15 miles west of Livingston, Ariz. It is about half a mile above the mouth.

The gage is a vertical rod nailed to a cliff of cemented gravel on the left bank. The following measurements were made by W. Richins during 1901:

List of discharge measurements of Tonto Creek near Livingston, Ariz.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1901.	*Feet.*	*Sec.-ft.*	1901.	*Feet.*	*Sec.-ft.*
July 10	2.57	2.34	August 28	2.90	3.31
July 13	2.56	2.02	August 31	2.85	2.79
July 20	2.55	1.92	September 2	2.85	2.80
July 24	2.85	18.50	September 7	2.85	2.60
July 25	3.20	54.00	September 10	3.00	7.52
July 27	3.50	99.17	September 14	2.85	2.30
August 3	3.82	108.02	September 27	2.65	1.85
August 5	2.90	37.50	October 5	2.70	2.05
August 10	2.60	5.90	October 12	2.70	1.78
August 11	4.60	279.00	October 23	2.75	2.08
August 15	2.90	34.61	November 6	2.85	1.86
August 17	2.75	16.33	December 2	2.85	1.80
August 20	2.63	11.24	December 13	2.85	2.54
August 24	3.10	4.98	December 20	2.85	2.34

Daily gage height, in feet, of Tonto Creek near Livingston, Ariz., for 1901.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.05	2.75	2.66	2.58	3.00	2.85	2.70	2.80	2.85
2	3.05	2.75	2.65	2.58	2.75	2.85	2.70	2.80	2.85
3	3.05	2.75	2.65	2.57	3.55	2.85	2.70	2.80	2.85
4	3.02	2.75	2.65	2.57	3.05	2.85	2.70	2.80	2.85
5	3.00	2.75	2.65	2.57	2.85	2.85	2.70	2.85	2.85
6	2.95	2.70	2.65	2.57	2.83	2.85	2.70	2.85	2.85
7	2.95	2.70	2.65	2.57	2.78	2.85	2.70	2.85	2.85
8	2.90	2.65	2.65	2.57	2.69	2.84	2.70	2.85	2.85
9	2.90	2.65	2.65	2.57	2.68	2.83	2.70	2.85	2.85
10	2.90	2.68	2.65	2.57	2.60	2.91	2.70	2.85	2.85
11	2.90	2.70	2.60	2.57	4.10	2.84	2.70	2.85	2.85
12	2.90	2.67	2.58	2.57	3.45	2.88	2.70	2.90	2.85
13	2.90	2.75	2.58	2.56	3.45	2.85	2.70	2.85	2.85
14	2.90	2.70	2.58	2.59	3.13	2.85	2.70	2.85	2.85
15	2.85	2.69	2.65	2.55	2.90	2.85	2.70	2.85	2.85
16	2.85	2.69	2.65	2.55	2.77	2.85	2.70	2.85	2.85
17	2.85	2.68	2.65	2.55	2.75	2.85	2.70	2.85	2.85
18	2.90	2.68	2.58	2.57	2.65	2.82	2.70	2.85	2.85
19	2.85	2.65	2.58	2.56	2.65	2.85	2.70	2.85	2.85
20	2.85	2.65	2.58	2.57	2.63	2.80	2.70	2.85	2.85
21	2.85	2.65	2.58	2.56	2.50	2.79	2.70	2.85	2.85
22	2.85	2.65	2.57	2.58	2.50	2.77	2.70	2.85	2.85
23	2.85	2.64	2.57	2.57	3.35	2.75	2.75	2.85	2.85
24	2.85	2.63	2.56	3.25	3.05	2.73	2.75	2.85	2.85
25	2.85	3.08	2.55	3.48	3.00	2.72	2.75	2.85	2.85
26	2.85	2.81	2.55	2.92	2.96	2.70	2.75	2.85	2.85
27	2.80	2.78	2.53	3.28	2.94	2.70	2.75	2.85	2.85
28	2.80	2.81	2.50	4.30	2.90	2.70	2.75	2.85	2.85
29	2.75	2.78	2.50	3.55	2.90	2.70	2.75	2.85	2.85
30	2.75	2.83	2.50	5.50	2.88	2.70	2.78	2.85	2.85
31	.....	2.90	.....	3.30	2.85	.....	2.80	.....	2.85

SALT RIVER AT McDOWELL, ARIZ.

The station, established April 20, 1897, is a half mile above the mouth of Verde River. It is described in Water-Supply Paper No. 50, page 386. The station was temporarily discontinued during 1900, but measurements were resumed in 1901. During 1901 the following measurements of discharge were made by F. P. Trott, J. F. Appleby, and J. C. Myrick.

List of discharge measurements of Salt River at McDowell, Ariz.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1901.	*Feet.*	*Sec.-ft.*	1901.	*Feet.*	*Sec.-ft.*
January 10	10.69	251	April 10	12.55	994
January 25	10.99	302	April 12	12.60	1,062
January 26	12.80	1,392	April 13	12.60	971
January 29	13.90	3,172	April 15	12 50	995
February 7	14.47	4,535	April 17	12.90	1,271
February 11	14.45	4,628	June 2	1.97	435
February 15	13.30	2,088	June 8	1.68	347
February 23	15.58	3,290	June 15	1.42	270
February 25	15.60	3,335	June 17	1.34	231
February 26	15.20	2,791	June 22	1.20	177
February 27	14.70	2,459	June 30	1.00	129
February 28	14.20	1,888	July 6	.88	100
March 1	14.10	1,664	July 13	.67	78
March 2	14.00	1,597	July 20	.60	66
March 4	14.20	1,711	July 27	1.60	329
March 5	4.20	1,687	August 10	2.28	357
March 8	13.90	1,817	August 17	2.30	329
March 9	14.30	2,502	August 31	1.84	245
March 11	14.90	3,157	September 7	1.53	171
March 12	14.40	2,634	September 14	1.69	198
March 13	14.15	2,045	September 21	1.55	152
March 14	13.80	1,942	September 28	1.36	122
March 16	13.35	1,541	October 5	1.30	118
March 18	13.10	1,427	October 12	1.40	151
March 19	13.00	1,351	October 19	1.42	142
Do	13.00	1,350	October 26	1.47	159
March 20	12.85	1,161	November 2	.88	183
Do	13.00	1,332	November 9	.83	173
March 21	12.90	1,198	November 16	.93	209
March 22	12.90	1,112	November 23	.90	194
March 25	12.85	1,210	November 30	.87	155
March 27	12.00	1,029	December 7	.85	180
March 29	12.60	893	December 14	.85	168
April 2	12.50	887	December 21	.79	166
April 8	12.50	1,016	December 28	.85	171
April 10	12.55	994	December 31	.83	157

Daily gage height, in feet, of Salt River at McDowell, Ariz., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	10.70	13.48	14.10	12.50	(a)	(a)	1.00	(a)	1.80	1.36	0.91	0.87
2	10.70	14.10	14.05	12.50	(a)	1.97	.96	(a)	1.74	1.36	.86	.86
3	10.70	13.50	14.10	12.50	(a)	1.93	.93	(a)	1.84	1.34	.83	.86
4	10.70	13.25	14.15	12.40	(a)	1.89	.89	(a)	1.77	1.33	.84	.86
5	10.69	13.23	14.13	12.35	(a)	1.85	.88	(a)	1.66	1.31	.82	.85
6	10.70	13.60	14.10	12.37	(a)	1.78	.88	(a)	1.61	1.41	.82	.85
7	10.70	14.40	13.98	12.40	(a)	1.70	.83	(a)	1.56	1.37	.84	.85
8	10.70	14.10	14.00	12.45	(a)	1.68	.81	(a)	1.51	1.39	.84	.84
9	10.70	13.90	14.30	12.50	(a)	1.64	.80	(a)	1.49	1.45	.83	.85
10	10.70	13.75	14.80	12.55	(a)	1.62	.80	2.28	1.46	1.46	.83	.85
11	10.78	14.75	14.90	12.60	(a)	1.58	.75	2.17	3.55	1.45	.82	.85
12	10.78	14.10	14.32	12.60	(a)	1.53	.70	4.80	2.05	1.40	.83	.86
13	10.78	14.18	14.05	12.60	(a)	1.52	.69	4.30	1.85	1.44	.86	.85
14	10.78	13.68	13.85	12.53	(a)	1.48	.69	3.80	1.69	1.45	.90	.86
15	10.68	13.40	13.65	12.50	(a)	1.42	.69	3.30	1.69	1.43	.86	.86
16	10.65	13.20	13.35	12.63	(a)	1.39	.68	2.80	1.71	1.42	.93	.86
17	10.70	13.25	13.23	12.98	(a)	1.36	.65	2.30	1.63	1.41	.92	.86
18	10.70	13.33	13.13	13.15	(a)	1.32	.63	(a)	1.61	1.42	.91	.83
19	10.70	13.83	13.00	13.13	(a)	1.30	.61	(a)	1.59	1.42	.92	.82
20	10.70	14.88	13.00	(a)	(a)	1.28	.60	(a)	1.52	1.43	.91	.80
21	10.65	14.80	12.90	(a)	(a)	1.25	.61	2.08	1.55	1.43	.92	.79
22	10.65	15.00	12.90	(a)	(a)	1.20	.70	2.10	1.52	1.43	.90	.83
23	10.70	15.48	12.85	(a)	(a)	1.18	.83	2.10	1.49	1.46	.89	.84
24	10.70	15.88	12.80	(a)	(a)	1.15	.90	2.42	1.43	1.46	.89	.85
25	10.95	15.43	12.85	(a)	(a)	1.13	1.05	1.95	1.45	1.47	.89	.86
26	12.70	15.10	12.85	(a)	(a)	1.10	1.65	1.86	1.45	1.47	.88	.85
27	13.23	14.68	12.78	(a)	(a)	1.07	1.60	1.79	1.44	1.48	.88	.85
28	13.35	14.18	12.70	(a)	(a)	1.05	2.00	1.78	1.37	1.49	.88	.85
29	13.90	.....	12.68	(a)	(a)	1.02	(a)	1.74	1.36	1.53	.87	.85
30	14.22	.....	12.58	(a)	(a)	1.01	(a)	1.75	1.36	1.59	.87	.84
31	14.00	.....	12.50	.....	(a)	.....	.....	1.84	.....	1.77	.....	.81

[a] No observations.

VERDE RIVER NEAR McDOWELL, ARIZ.

This station, established April 20, 1897, is three-fourths of a mile above the mouth of the river, and is described in Water-Supply Paper

No. 50, page 387. Records were not kept during 1900, but they were resumed in 1901. During 1901 the following measurements were made by F. P. Trott, J. F. Appleby, and J. C. Myrick:

List of discharge measurements of Verde River near McDowell, Ariz.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1901.	*Feet.*	*Sec.-ft.*	1801.	*Feet.*	*Sec.-ft.*
January 10	4.05	268	April 12	4.65	216
January 26	4.40	301	April 13	4.60	194
January 27	6.00	1,557	April 15	4.50	189
February 8	5.75	1,331	May 25	4.38	125
February 11	6.38	2,489	June 1	4.48	156
February 15	5.35	793	June 8	4.38	129
February 21	7.60	3,308	June 15	4.25	194
February 23	9.30	6,613	June 22	4.20	76
February 24	9.48	6,022	June 30	4.13	51
February 25	7.83	3,819	July 6	4.04	37
February 27	6.85	2,499	July 13	4.03	33
February 28	6.70	2,393	July 20	4.11	47
March 2	6.80	2,863	July 27	4.88	278
March 4	6.17	1,628	August 3	7.85	1,746
March 7	5.60	1,099	August 10	5.70	438
March 9	5.40	966	August 17	5.75	513
March 11	6.40	1,695	August 31	4.95	164
March 12	5.80	1,199	September 7	4.80	105
March 13	5.75	989	September 14	4.62	104
March 14	5.55	914	September 21	4.70	104
March 15	5.45	823	September 30	4.65	82
March 16	5.30	705	October 5	4.76	101
March 18	5.10	576	October 12	4.70	140
March 19	5.00	469	October 19	4.74	105
March 20	5.00	436	October 26	4.91	160
March 21	4.90	395	October 31	5.79	495
March 22	4.90	368	November 2	5.27	282
March 23	4.80	350	November 9	5.12	250
March 26	4.70	274	November 16	5.24	235
March 27	4.65	225	November 23	5.22	239
March 28	4.65	224	November 30	5.23	219
March 29	4.65	215	December 7	5.25	257
April 1	4.60	211	December 14	5.25	291
April 2	4.65	221	December 21	5.25	213
April 3	4.65	188	December 23	5.31	235
April 8	4.60	188	December 31	5.30	231
April 10	4.55	192			

Daily gage height, in feet, of Verde River near McDowell, Ariz., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4.05	5.15	6.30	4.60	4.45	4.43	4.10	6.30	4.98	4.66	5.44	5.22
2	4.05	5.42	6.60	4.65	4.42	4.48	4.08	6.55	4.95	4.73	5.26	5.25
3	4.05	5.15	6.50	4.63	4.44	4.48	4.10	7.85	4.87	4.76	5.17	5.25
4	4.05	4.92	6.28	4.55	4.42	4.44	4.07	6.30	4.85	4.76	5.05	5.26
5	4.05	4.90	6.48	4.55	4.42	4.42	4.07	7.40	4.85	4.76	5.03	5.25
6	4.05	5.25	5.80	4.55	4.42	4.39	4.04	6.30	4.83	4.76	5.04	5.25
7	4.05	5.90	5.65	4.55	4.42	4.42	4.05	6.40	4.80	4.75	5.10	5.25
8	4.05	5.75	5.50	4.55	4.41	4.38	4.06	6.17	4.78	4.77	5.10	5.27
9	4.05	5.45	5.40	4.55	4.41	4.33	4.06	5.90	4.74	4.80	5.12	5.29
10	4.05	5.25	6.25	4.55	4.40	4.31	4.04	5.70	4.70	4.75	5.12	5.24
11	4.05	6.35	6.20	4.60	4.37	4.30	4.03	5.85	4.68	4.72	5.09	5.24
12	4.00	5.90	5.95	4.63	4.35	4.29	4.04	5.70	4.66	4.71	5.12	5.23
13	4.05	5.65	5.75	4.60	4.35	4.28	4.03	5.50	4.65	4.72	5.31	5.20
14	4.00	5.57	5.50	4.55	4.37	4.28	4.04	6.00	4.62	4.75	5.29	5.25
15	4.00	5.30	5.45	4.53	4.37	4.25	4.04	7.50	4.62	4.76	5.24	5.26
16	4.00	5.22	5.25	4.50	4.37	4.28	4.04	6.10	4.62	4.76	5.24	5.29
17	4.05	5.32	5.15	4.50	4.37	4.25	4.06	5.75	4.62	4.75	5.24	5.31
18	4.03	5.33	5.00	4.55	4.37	4.22	4.08	6.30	4.59	4.79	5.25	5.25
19	4.00	5.80	5.00	4.55	4.37	4.25	4.09	6.40	4.52	4.75	5.23	5.24
20	4.00	6.56	5.00	4.50	4.37	4.23	4.11	5.85	4.61	4.76	5.22	5.25
21	4.02	7.50	4.70	4.50	4.40	4.23	4.11	5.70	4.70	4.77	5.22	5.25
22	4.00	8.00	4.90	4.50	4.35	4.20	4.06	5.70	4.65	4.75	5.22	5.25
23	4.02	9.45	4.80	4.50	4.38	4.21	4.95	5.60	4.60	4.82	5.22	5.26
24	4.00	9.20	4.80	4.50	4.38	4.20	4.84	5.40	4.63	4.88	5.22	5.28
25	4.13	8.05	4.75	4.47	4.38	4.18	4.75	5.20	4.60	4.88	5.23	5.29
26	4.27	7.57	4.70	4.47	4.37	4.16	4.90	5.10	4.60	4.91	5.24	5.30
27	5.88	7.05	4.65	4.45	4.37	4.13	4.88	5.05	4.65	4.91	5.24	5.32
28	5.13	6.48	4.65	4.48	4.38	4.13	5.85	5.05	4.66	4.92	5.24	5.32
29	4.50	.....	4.65	4.50	4.45	4.13	6.00	5.00	4.66	4.93	5.23	5.30
30	5.60	.....	4.60	4.47	4.55	4.13	6.70	5.00	4.65	5.26	5.23	5.28
31	5.28	.....	4.60	.....	4.52	.....	7.20	4.95	.....	5.50	.....	5.30

COLORADO RIVER AT YUMA, ARIZ.

This station was established in April, 1878, by the Southern Pacific Company, which has maintained daily readings since that time. It is through the courtesy of that company that the records are furnished to the Geological Survey. The station is described in Water-Supply Paper No. 50, page 387. One measurement of discharge was made during 1901 by H. G. Heisler, on August 18, the discharge being 18,683 second-feet for a gage height of 20.71 feet.

Daily gage height, in feet, of Colorado River at Yuma, Ariz., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	17.1	17.2	19.8	18.5	20.5	27.0	23.9	19.6	19.2	17.2	17.2	17.7
2	17.0	17.2	20.2	18.4	21.0	27.0	24.1	19.8	19.1	17.1	17.3	17.7
3	16.9	17.2	20.0	18.3	21.2	26.7	23.9	19.8	19.2	17.0	17.3	17.5
4	16.9	17.3	20.0	18.4	21.8	26.4	23.8	19.8	19.1	16.9	17.3	17.5
5	17.0	17.4	19.7	18.3	22.3	26.2	23.6	19.9	19.0	16.8	17.4	17.5
6	17.0	17.7	19.6	18.3	22.6	26.2	23.2	20.0	19.1	16.8	17.5	17.6
7	17.0	18.0	19.5	18.3	22.7	25.9	23.0	20.4	19.3	16.8	17.5	17.6
8	17.0	18.3	19.3	18.3	23.2	25.6	23.1	20.1	19.3	16.7	17.5	17.5
9	16.9	18.5	19.2	18.3	23.7	25.3	23.0	20.0	19.0	16.8	17.5	17.5
10	16.8	20.7	19.0	18.2	24.1	24.9	22.7	20.2	19.3	16.8	17.5	17.5
11	16.6	19.2	19.0	18.2	23.9	24.7	22.7	19.7	19.1	16.8	17.5	17.5
12	16.4	18.7	19.2	18.2	23.6	24.5	22.6	19.4	18.7	16.8	17.5	17.5
13	16.3	18.7	19.2	18.2	23.7	24.2	22.4	19.3	18.7	16.8	17.5	17.6
14	16.2	18.7	19.3	18.0	23.7	24.2	22.1	20.0	18.7	16.8	17.7	17.5
15	16.2	18.6	19.3	17.9	23.5	24.0	21.9	19.5	19.0	16.8	17.6	17.5
16	16.4	18.5	19.3	17.9	23.4	24.2	21.7	19.3	18.8	16.8	17.7	17.5
17	16.5	18.7	19.5	17.9	23.4	24.3	21.4	19.3	18.7	16.8	17.7	17.5
18	16.5	18.7	19.6	17.9	23.7	24.4	21.2	20.7	18.5	16.9	17.7	17.7
19	16.7	18.6	20.0	18.0	24.0	24.5	21.1	20.0	18.3	16.9	17.7	17.7
20	17.0	18.3	19.7	18.1	24.2	24.2	21.0	19.6	18.2	16.9	17.6	17.7
21	17.0	18.2	19.6	18.1	24.5	24.0	20.9	19.6	17.9	16.9	17.5	17.7
22	16.8	18.1	19.3	18.2	24.8	23.8	20.9	19.3	17.8	17.0	17.5	17.8
23	16.8	18.0	19.2	18.2	25.2	23.7	20.7	19.2	17.7	17.1	17.5	17.8
24	16.8	18.0	19.1	18.3	25.5	23.5	20.6	19.0	17.6	17.2	17.5	17.8
25	17.0	18.2	19.0	18.6	25.6	23.3	20.4	19.1	17.6	17.2	17.5	17.8
26	17.1	18.4	18.8	18.7	25.9	23.2	20.2	19.1	17.6	17.2	17.5	17.7
27	17.1	18.7	18.7	18.8	26.3	23.3	20.1	18.7	17.5	17.2	17.5	17.6
28	17.1	18.8	18.7	19.2	26.7	23.7	19.9	19.2	17.5	17.2	17.5	17.5
29	17.0	.....	18.5	19.7	26.8	23.7	19.7	20.4	17.4	17.2	17.6	17.2
30	17.0	.....	18.5	19.4	26.9	23.7	19.5	20.1	17.3	17.2	17.7	17.0
31	17.0	.....	18.6	.....	27.0	.....	19.3	19.7	.....	17.2	.....	17.0

INTERIOR BASIN DRAINAGE.

HUMBOLDT RIVER NEAR ELKO, NEV.

This station was established by L. H. Taylor on June 17, 1895, at the highway bridge 1 mile southwest of the town of Elko. It is described in Water-Supply Paper No. 51, page 395. Results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 399. During 1901 measurements of discharge were made by L. H. Taylor, as follows:

April 12: Gage height, 3.25 feet; discharge, 249 second-feet.
April 25: Gage height, 3.65 feet; discharge, 358 second-feet.

Daily gage height, in feet, of Humboldt River near Elko, Nev., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.35	2.35	5.50	3.35	3.65	4.30	2.10	1.90	1.60	1.85	1.80	1.85
2	2.35	2.35	5.40	3.35	3.70	4.30	2.20	2.10	1.60	1.90	1.79	1.85
3	2.34	2.35	5.50	3.32	3.80	4.40	2.30	2.10	1.60	1.95	1.80	1.85
4	2.34	2.35	5.50	3.30	3.90	4.40	2.50	2.10	1.60	2.00	1.80	1.85
5	2.34	2.35	5.00	3.30	4.00	4.40	2.70	2.10	1.65	1.95	1.80	1.85
6	2.25	2.35	4.80	3.30	4.00	4.40	2.60	2.20	1.65	1.80	1.80	1.85
7	2.35	2.35	4.50	3.33	4.00	4.30	2.60	2.10	1.70	1.75	1.80	1.85
8	2.35	2.35	4.30	3.32	3.90	4.30	2.50	2.00	1.70	1.75	1.80	1.85
9	2.35	2.35	4.10	3.30	3.80	4.20	2.50	1.90	1.70	1.75	1.80	1.85
10	2.40	2.35	4.00	3.30	3.70	4.10	2.40	1.90	1.75	1.80	1.85	1.85
11	2.40	2.30	3.90	3.28	3.60	4.00	2.30	1.90	1.75	1.80	1.85	1.85
12	2.40	2.29	3.90	3.25	3.50	3.90	2.30	1.90	1.75	1.80	1.80	1.85
13	2.35	2.28	3.80	3.23	3.50	3.80	2.30	1.85	1.80	1.80	1.80	1.85
14	2.35	2.26	3.80	3.30	3.50	3.70	2.30	1.85	1.80	1.75	1.85	1.85
15	2.35	2.25	3.70	3.30	3.60	3.60	2.25	1.80	1.80	1.75	1.85	1.85
16	2.35	2.25	3.65	3.35	3.80	3.50	2.20	1.80	1.80	1.75	1.85	1.85
17	2.35	3.75	3.55	3.35	4.10	3.40	2.20	1.80	1.85	1.76	1.85	1.85
18	2.40	4.30	3.55	3.40	4.30	3.30	2.15	1.80	1.85	1.78	1.85	1.85
19	2.40	5.55	3.50	3.40	4.50	3.20	2.10	1.80	1.90	1.80	1.85	1.85
20	2.40	6.60	3.50	3.40	4.70	3.20	2.10	1.70	1.90	1.80	1.85	1.85
21	2.38	7.40	3.50	3.45	4.90	3.10	2.10	1.70	1.95	1.79	1.85	1.85
22	2.38	6.70	3.50	3.45	5.00	3.00	2.10	1.65	1.90	1.78	1.85	1.85
23	2.38	7.10	3.45	3.50	5.00	3.00	2.10	1.60	1.90	1.77	1.85	1.85
24	2.35	7.95	3.40	3.60	5.00	3.00	2.05	1.60	1.85	1.76	1.85	1.85
25	2.38	7.65	3.45	3.63	4.80	2.90	2.05	1.60	1.85	1.77	1.85	1.85
26	2.38	7.20	3.45	3.68	4.60	2.80	2.25	1.60	1.80	1.77	1.85	1.85
27	2.35	6.50	3.45	3.70	4.40	2.80	2.00	1.60	1.80	1.80	1.85	1.85
28	2.35	5.60	3.50	3.65	4.20	2.90	1.98	1.65	1.80	1.79	1.85	1.85
29	2.35	.....	3.50	3.60	4.20	2.90	1.98	1.70	1.80	1.78	1.85	1.85
30	2.35	.....	3.50	3.60	4.00	2.10	1.90	1.65	1.80	1.79	1.85	1.85
31	2.35	.....	3.38	.....	4.10	.....	1.90	1.60	.....	1.80	.....	1.85

SOUTH FORK OF HUMBOLDT RIVER AT MASON'S RANCH, NEVADA.

The station, established August 29, 1896, is 10 miles southwest of the town of Elko. It is described in Water-Supply Paper No. 51, page 396. Results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 400. During 1901 measurements were made by L. H. Taylor, as follows:

April 25: Gage height, 1.80 feet; discharge, 231 second-feet.
October 13: Gage height, 0.70 foot; discharge, 36 second-feet.

The latter measurement was made at a point 3 miles above the gage, where the discharge is practically the same as at the station.

Daily gage height, in feet, of South Fork of Humboldt River at Mason's ranch, Nevada, for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	0.60	0.70	2.40	1.30	2.00	2.90	1.60	0.75	0.35	0.55	0.80	0.95
2	.60	.70	2.10	1.30	2.00	2.90	1.50	.75	.35	.60	.80	.95
3	.60	.70	2.00	1.30	2.00	3.00	1.50	.75	.35	.65	.80	.95
4	.60	.70	1.80	1.30	2.00	3.00	1.50	.70	.35	.65	.80	.95
5	.60	.70	1.80	1.30	2.00	3.10	1.50	.70	.35	.70	.80	.95
6	.70	.70	1.50	1.30	2.10	3.10	1.50	.70	.35	.75	.80	.95
7	.70	.70	1.50	1.40	2.10	3.10	1.10	.70	.35	.75	.80	.95
8	.70	.70	1.50	1.49	2.10	3.10	1.10	.70	.40	.75	.80	.95
9	.70	.70	1.50	1.45	2.20	2.50	1.10	.70	.40	.75	.80	.95
10	.70	.80	1.50	1.45	2.20	2.50	1.10	.70	.40	.75	.85	.95
11	.70	.80	1.50	1.50	2.20	2.40	1.10	.60	.40	.75	.85	.95
12	.70	.80	1.50	1.50	2.90	2.40	1.10	.60	.40	.75	.85	.95
13	.70	.85	1.50	1.50	3.00	2.40	1.10	.60	.40	.70	.85	.95
14	.70	.85	1.50	1.50	3.00	2.25	1.00	.60	.40	.70	.85	.95
15	.70	.90	1.50	1.50	3.10	2.35	1.00	.60	.40	.70	.85	.85
16	.70	.90	1.50	1.50	3.20	2.00	1.00	.60	.40	.70	.85	.85
17	.70	[a]5.00	1.45	1.55	3.20	2.00	1.00	.60	.40	.70	.85	.70
18	.70	6.00	1.45	1.55	3.20	2.00	.90	.50	.40	.70	.85	.70
19	.70	6.00	1.45	1.55	3.00	2.00	.90	.45	.40	.70	.85	.70
20	.70	6.00	1.45	1.55	3.00	2.10	.80	.45	.40	.70	.85	.70
21	.70	5.00	1.40	1.80	2.80	2.15	.75	.40	.40	.70	.90	.70
22	.70	4.00	1.40	1.80	2.50	2.15	.75	.40	.45	.70	.90	.70
23	.70	3.10	1.40	1.80	2.50	2.20	.75	.40	.45	.70	.90	.70
24	.70	3.00	1.35	1.85	2.40	2.10	.75	.40	.45	.70	.95	.70
25	.70	3.00	1.35	1.90	2.40	2.10	.75	.40	.50	.70	.95	.70
26	.70	2.80	1.30	1.90	2.85	2.00	.75	.40	.50	.70	.95	.70
27	.70	2.80	1.30	1.95	2.85	2.00	.75	.40	.50	.75	.95	.70
28	.70	2.50	1.30	1.90	2.90	1.80	.75	.35	.50	.75	.95	.70
29	.70	------	1.30	1.90	2.90	1.80	.75	.35	.50	.75	.95	.75
30	.70	------	1.30	1.90	2.90	1.60	.75	.35	.55	.80	.95	.75
31	.70	------	1.30	------	2.90	------	.75	.35	------	.80	------	.75

[a] Ice gorge below gage gave way during night of 17th.

HUMBOLDT RIVER NEAR GOLCONDA, NEV.

This station is near the great northern bend of Humboldt River and below the central valley. It is about 12 miles above the mouth of Little Humboldt River. It was established October 24, 1894, and is described in Water-Supply Paper No. 51, page 397. Results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 401. During 1901 the following measurements were made by L. H. Taylor:

List of discharge measurements of Humboldt River near Golconda, Nev.

Date.	Hydrographer.	Gage height.	Discharge.	Date.	Hydrographer.	Gage height.	Discharge.
1901.		*Feet.*	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
January 7	C. V. Taylor	1.05	43	April 10	C. V. Taylor	4.07	450
February 18	L. H. Taylor	2.20	141	April 18	do	3.75	388
March 2	do	7.50	1,661	May 5	do	4.25	537
March 24	C. V. Taylor	5.10	714	October 24	L. H. Taylor	.10	4
April 1	do	4.55	571				

Daily gage height, in feet, of Humboldt River near Golconda, Nev., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.00	1.70	7.25	4.50	4.15	3.90	2.20	0.05	0.10	+0.15	1.10	0.20
2	1.00	1.60	7.50	4.50	4.35	3.70	2.10	.05	.05	+ .15	.15	.30
3	1.00	1.60	7.85	4.45	4.35	3.80	2.05	.05	.05	+ .15	.15	.40
4	1.00	1.70	8.20	4.40	4.30	3.75	2.05	.05	.00	+ .20	.10	.50
5	1.00	1.70	8.70	3.95	4.20	3.70	2.00	.20	.00	+ .20	.15	.60
6	1.05	1.60	8.90	3.50	4.05	3.65	2.00	.30	.00	+ .15	.15	.65
7	1.05	1.60	9.00	3.55	4.00	3.60	1.90	.40	− .05	.15	.10	.65
8	1.05	1.50	9.10	3.60	4.00	3.60	1.80	.40	− .05	.10	.10	.55
9	1.10	1.70	8.90	3.80	3.80	3.60	1.70	.45	− .10	.05	.15	.60
10	1.10	1.70	8.50	4.05	3.65	3.55	1.50	.45	− .10	− .05	.15	.60
11	1.10	1.70	8.20	4.00	3.60	3.50	1.35	.50	− .05	− .10	.15	.60
12	1.15	1.70	8.30	4.00	3.60	3.45	1.20	.55	− .05	− .10	.10	.60
13	1.15	1.70	8.40	4.00	3.55	3.25	1.05	.55	− .10	+ .10	.10	.65
14	1.30	1.60	8.00	3.95	3.50	3.05	.95	.60	− .10	.10	.15	.70
15	1.50	1.30	7.70	3.85	3.45	3.05	.80	.65	− .05	.15	.15	.75
16	1.70	1.50	6.90	3.90	3.40	3.05	.60	.50	− .10	.15	.10	.75
17	1.80	1.80	6.20	3.80	3.40	3.05	.50	.40	− .05	.15	.15	.80
18	1.90	2.20	6.00	3.70	3.40	3.05	.45	.25	− .10	.15	.15	.80
19	1.70	2.80	5.80	3.70	3.10	3.10	.35	.30	− .15	.05	.10	.85
20	1.30	3.40	5.60	3.75	3.10	3.00	.25	.30	− .15	.15	.10	.85
21	1.35	4.20	5.50	3.85	3.20	2.95	.20	.35	− .05	.10	.15	.90
22	1.40	4.90	5.35	3.90	3.20	2.90	.20	.30	− .10	.15	.15	.95
23	1.45	5.10	5.20	3.85	3.30	2.80	.20	.25	− .10	.10	.10	.95
24	1.50	5.30	5.10	3.75	3.50	2.60	.15	.25	− .10	.15	.10	.95
25	1.60	5.60	4.95	3.75	3.60	2.40	.15	.20	− .10	.15	.10	1.00
26	1.80	6.00	4.90	3.75	3.70	2.40	.10	.25	− .05	.15	.15	1.10
27	1.75	6.40	4.90	3.75	3.80	2.45	.10	.25	− .10	.15	.15	1.10
28	1.60	6.70	4.80	3.75	3.95	2.40	.05	.20	− .10	.15	.10	1.20
29	1.40	------	4.75	3.80	4.00	2.40	.05	.10	− .05	.10	.10	1.20
30	1.60	------	4.65	3.90	4.10	2.35	.05	.15	− .10	.15	.15	1.20
31	1.80	------	4.50	------	4.00	------	.05	.10	-------	.10	------	1.20

HUMBOLDT RIVER NEAR OREANA, NEV.

This station, established January 27, 1896, is 1½ miles above the old Oreana highway bridge. It is 12 miles northeast of Lovelocks and above all of the canals diverting water in the vicinity of that town. It is described in Water-Supply Paper No. 51, page 398. Results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 402. During 1901 the following measurements of discharge were made by C. V. and L. H. Taylor:

List of discharge measurements of Humboldt River near Oreana, Nev.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1901.	*Feet.*	*Sec.-ft.*	1901.	*Feet.*	*Sec.-ft.*
March 15	4.80	2,180	April 23	2.35	341
March 22	4.20	1,467	April 26	2.60	423
April 5	3.50	958	July 2	1.40	131
April 13	3.10	634	August 10	.50	45

Daily gage height, in feet, of Humboldt River near Oreana, Nev., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.30	1.10	2.80	2.30	2.60	1.50	1.20	0.70	0.10	0.10	0.40	0.30
2	1.00	1.10	3.10	2.60	2.60	1.50	1.40	.60	.00	2.10	.40	.30
3	1.00	1.10	3.30	2.90	2.70	1.50	1.50	.60	.00	1.00	.30	.90
4	.90	1.10	3.30	3.30	2.80	1.50	1.50	.50	.00	.60	.30	.90
5	.90	1.20	3.40	3.50	2.80	1.40	1.50	.40	−.10	.30	.30	.50
6	.90	1.40	3.80	3.50	2.80	1.40	1.50	.70	−.10	.30	.30	.50
7	.90	1.40	3.80	3.60	2.60	1.30	1.50	1.00	.10	.30	.20	.40
8	1.00	1.60	4.00	3.50	2.50	1.30	1.50	.70	−.10	.30	.20	.40
9	1.20	1.60	4.20	3.40	2.50	1.30	1.50	.50	−.10	.30	.20	.40
10	1.20	1.60	4.20	3.40	2.40	1.30	1.30	.50	.15	.20	.20	.50
11	1.40	1.60	4.20	3.10	2.40	1.40	1.30	.50	.10	.20	.20	.70
12	1.40	1.60	4.40	3.10	2.40	1.40	1.20	.50	−.10	.20	.20	.90
13	1.40	2.00	4.50	3.00	2.40	1.50	1.20	.50	−.10	.20	.20	.60
14	1.40	2.60	4.60	2.90	2.50	1.60	1.30	.40	−.20	.20	.20	.50
15	1.40	3.00	4.80	2.90	2.30	1.60	1.30	.40	−.20	.20	.20	.50
16	1.60	2.60	5.00	2.80	2.20	1.60	1.20	.40	.10	.20	.20	.50
17	1.70	2.40	5.10	2.80	2.20	1.50	1.20	.30	.00	.20	.20	.70
18	1.80	1.90	4.90	2.80	2.10	1.50	1.10	.30	.00	.10	.20	.70
19	1.80	1.90	4.60	2.70	2.10	1.40	1.10	.30	.00	.10	.20	.40
20	1.80	1.80	4.60	2.70	2.00	1.40	1.10	.30	.10	.10	.30	.40
21	1.80	1.70	4.40	2.80	2.00	1.40	1.10	.30	.10	.10	.40	.50
22	1.40	1.70	4.20	2.70	1.90	1.30	1.10	.20	.10	.10	.30	.50
23	1.00	1.60	4.20	2.70	1.90	1.30	1.00	.20	.10	.10	.30	.50
24	1.00	1.60	4.00	2.70	1.90	1.30	1.00	.20	.10	.10	.30	.60
25	.80	1.80	3.70	2.60	1.80	1.20	.90	.20	.10	.10	.30	.70
26	.70	2.00	3.40	2.60	1.80	1.20	.90	.20	.10	.10	.30	.70
27	.70	2.10	3.20	2.60	1.80	1.20	.80	.20	.10	1.90	.30	.70
28	.70	2.60	2.80	2.60	1.70	1.20	.80	.10	.10	1.20	.30	.60
29	.80	.....	2.50	2.60	1.70	1.10	.80	.10	.10	.90	.30	.60
30	1.00	.....	2.20	2.60	1.60	1.10	.70	.10	.10	.50	.30	.60
31	1.00	.....	2.30	.....	1.60	.....	.70	.10	.....	.50	.....	.70

EAST FORK OF CARSON RIVER NEAR GARDNERVILLE, NEV.

This station was established by L. H. Taylor on October 17, 1900, at the place where measurements were made in the years 1890, 1891, and 1892, the results of which are given in the Thirteenth Annual Report, Part III, page 95. It is described in Water-Supply Paper No. 51, page 399. On August 2 a loose rock dam was raised a short distance below the gaging station, which affected the velocity at the latter point. The dam was partly washed out by a freshet on December 4, 1901. A new gage was established on March 10, 1901, a short distance downstream from the original one, which had been destroyed. It consists of a vertical timber driven into the stream bed at the right bank and spiked to a cottonwood tree. A bench mark was also established on a large granite bowlder 20 feet south of the gage under the cable from which the measurements are made. Its elevation is 8.10 feet above the datum of the gage. During 1901 the following measurements were made by F. H. Newell, L. H. Taylor, and others:

List of discharge measurements of East Fork Carson River near Gardnerville, Nev.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1901.	*Feet.*	*Sec-ft.*	1901.	*Feet.*	*Sec.-ft.*
March 10	4.00	459	September 29	3.70	[a] 127
April 30	4.55	[a] 864	November 7	3.70	[a] 117
June 4	5.85	1,868	December 19	3.40	156
June 9	5.40	1,356			

[a] Approximate.

Daily gage height, in feet, of East Fork Carson River near Gardnerville, Nev., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.40	2.00	4.70	3.80	4.60	5.70	5.50	3.70	3.40	3.90	4.00	3.80
2	2.40	2.10	4.70	3.70	4.60	5.80	5.40	3.70	3.50	3.90	4.00	3.80
3	2.40	2.10	4.70	3.70	4.70	6.10	5.30	4.10	3.50	3.80	4.00	3.80
4	2.50	2.10	4.60	3.70	4.70	5.90	5.30	4.10	3.50	3.70	4.10	5.10
5	2.80	2.10	4.60	3.60	4.70	5.80	5.10	4.20	3.50	3.70	4.10	4.70
6	3.00	2.00	4.50	3.60	4.90	5.80	5.00	4.30	3.60	3.70	4.10	4.30
7	2.90	2.00	4.40	3.70	5.10	5.70	4.90	4.40	3.85	3.60	3.90	4.10
8	2.80	2.00	4.40	3.80	5.40	5.60	4.80	4.30	3.80	3.60	3.70	3.80
9	2.60	1.90	4.20	3.80	5.70	5.60	4.70	4.20	3.80	3.50	3.70	3.80
10	2.50	1.90	4.00	3.80	5.90	5.50	4.60	4.10	3.90	3.50	4.00	3.80
11	2.50	1.90	4.00	3.90	6.70	5.40	4.50	3.90	3.90	3.50	3.90	3.70
12	2.50	2.00	3.90	4.10	7.00	5.20	4.40	3.90	3.80	3.50	3.90	3.70
13	2.50	2.00	3.70	4.20	7.10	5.00	4.30	3.80	3.80	3.50	3.80	3.70
14	2.40	2.00	3.60	4.30	7.20	5.00	4.20	3.70	3.70	3.50	3.70	3.70
15	2.40	2.60	3.60	4.40	7.30	5.10	4.10	3.50	3.70	3.50	3.70	3.70
16	2.30	5.50	3.80	4.40	7.30	5.10	4.10	3.50	3.70	3.50	3.70	3.70
17	2.30	6.40	4.00	4.40	7.40	5.30	4.00	3.60	3.70	3.50	3.60	3.60
18	2.30	6.00	4.00	4.40	7.20	5.30	4.10	4.50	3.60	3.50	3.60	3.40
19	2.40	6.00	3.90	4.60	7.10	5.40	4.10	4.30	3.50	3.50	3.70	3.40
20	1.90	5.70	3.90	4.70	5.90	5.50	4.20	4.30	3.50	3.50	3.70	3.40
21	2.00	5.50	3.80	4.60	5.80	5.50	4.20	4.10	3.40	3.50	3.70	3.40
22	2.00	5.00	3.90	4.60	5.70	5.40	4.20	3.90	3.40	3.50	3.70	3.40
23	2.00	5.00	3.80	4.50	5.60	5.30	4.60	3.80	3.40	3.50	3.70	3.30
24	2.00	5.00	3.80	4.50	5.50	5.30	4.30	3.70	3.40	3.50	3.70	3.40
25	2.00	4.90	3.80	4.50	5.30	5.20	4.10	3.50	3.80	3.60	3.60	3.40
26	2.10	4.90	3.80	4.50	5.30	5.30	4.00	3.50	3.80	3.60	3.60	3.30
27	2.10	4.80	3.70	4.50	5.30	5.40	4.00	3.40	3.70	3.70	3.70	3.40
28	2.10	4.70	3.60	4.50	5.40	5.50	3.90	3.40	3.70	3.70	3.70	3.40
29	2.10	.....	3.60	4.50	5.40	5.60	3.90	3.40	3.70	3.90	4.10	3.30
30	2.00	.....	3.70	4.50	5.50	5.70	3.80	3.40	3.70	4.00	3.90	3.40
31	1.90	.....	3.80	.....	5.60	.....	3.70	3.60	.....	4.00	.....	3.30

WEST FORK OF CARSON RIVER AT WOODFORDS, CAL.

The station, established by L. H. Taylor on October 18, 1900, is about three-fourths of a mile above Woodfords, near the point where measurements were made in 1890, 1891, and 1892, the results of which are given in the Thirteenth Annual Report, Part III, page 96. It is described in Water-Supply Paper No. 51, page 400. During 1901 the following discharge measurements were made by F. H. Newell, L. H. Taylor, and others:

List of discharge measurements of West Fork Carson River at Woodfords, Cal.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1901.	*Feet.*	*Sec.-ft.*	1901.	*Feet.*	*Sec.-ft.*
March 8	3.30	1.58	June 13	3.75	2.74
April 28	3.95	[a] 3.21	September 21	2.35	.31
May 26	3.80	2.85	November 6	2.60	.68
May 31	4.05	[a] 3.50			

[a] Approximate.

Daily gage height, in feet, of West Fork Carson River at Woodfords, Cal., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.65	2.45	3.70	3.05	3.90	4.10	3.40	3.00	2.50	2.50	2.60	2.70
2	2.65	2.50	3.70	3.10	3.90	4.20	3.30	2.90	2.50	2.50	2.60	2.70
3	2.50	2.45	3.65	3.10	3.90	4.10	3.20	2.90	2.50	2.50	2.50	2.70
4	2.55	2.45	3.60	3.10	3.90	4.10	3.00	2.90	2.50	2.50	2.50	2.70
5	2.50	2.40	3.60	3.05	3.90	4.20	3.10	3.00	2.40	2.50	2.50	2.60
6	2.50	2.40	3.50	3.05	4.05	4.10	3.10	3.30	2.40	2.50	2.50	2.60
7	2.55	2.40	3.50	3.05	4.45	4.10	3.20	2.90	2.40	2.50	2.50	2.70
8	2.60	2.40	3.40	3.05	4.60	4.10	3.20	2.90	2.40	2.50	2.50	2.70
9	2.60	2.40	3.40	3.05	4.75	3.80	3.10	2.90	2.40	2.50	2.50	2.70
10	2.55	2.40	3.35	3.15	5.05	3.80	3.20	2.80	2.40	2.50	2.60	2.70
11	2.50	2.45	3.30	3.15	5.30	3.80	3.20	2.80	2.40	2.40	2.50	2.70
12	2.50	2.40	3.30	3.20	5.40	3.80	3.20	2.70	2.40	2.50	2.50	2.70
13	2.55	2.45	3.30	3.30	5.35	3.70	3.20	2.70	2.40	2.50	2.60	2.80
14	2.55	2.55	3.25	3.40	5.15	3.70	3.10	2.60	2.40	2.50	2.60	2.80
15	2.60	2.60	3.25	3.45	4.85	3.70	3.20	2.70	2.40	2.50	2.60	2.80
16	2.60	2.70	3.30	3.50	4.70	3.70	3.20	2.70	2.40	2.50	2.50	2.80
17	2.55	3.10	3.25	3.65	4.60	3.70	3.30	2.70	2.40	2.50	2.50	2.80
18	2.50	3.20	3.20	3.70	4.45	3.70	3.20	2.90	2.40	2.40	2.50	2.80
19	2.50	3.30	3.20	3.70	4.70	3.80	3.20	2.80	2.40	2.40	2.60	2.80
20	2.45	3.30	3.20	3.75	4.55	3.90	3.00	2.70	2.40	2.40	2.60	2.80
21	2.40	3.40	3.20	3.80	4.35	3.80	3.00	2.60	2.40	2.40	2.60	2.80
22	2.40	3.40	3.20	4.05	4.10	3.80	3.10	2.50	2.40	2.40	2.60	2.80
23	2.40	3.40	3.15	4.05	4.10	3.80	3.30	2.50	2.40	2.50	2.60	2.80
24	2.45	3.60	3.15	4.05	4.00	3.90	3.20	2.50	2.40	2.50	2.60	2.90
25	2.45	3.60	3.15	4.25	4.00	3.60	3.10	2.50	2.40	2.50	2.60	2.90
26	2.40	3.60	3.15	4.25	3.95	3.50	3.00	2.50	2.40	2.50	2.60	3.00
27	2.40	3.65	3.15	4.25	3.90	3.40	3.00	2.50	2.40	2.50	2.60	2.90
28	2.45	3.70	3.15	4.25	3.90	3.40	3.00	2.50	2.40	2.60	2.60	2.90
29	2.45	.....	3.10	4.10	3.85	3.70	3.00	2.80	2.50	2.60	2.60	2.90
30	2.40	.....	3.10	4.05	3.95	3.50	2.90	2.50	2.50	2.60	2.60	2.90
31	2.45	.....	3.05	.....	4.05	.....	2.90	2.50	.....	2.60	.....	3.00

CARSON RIVER NEAR EMPIRE, NEV.

The station, established October 21, 1900, by L. H. Taylor, is about 2 miles below the town of Empire and about three-fourths of a mile below the point where measurements were made by Mr. Taylor in 1895, the results of which are published in Bulletin No. 140 of the United States Geological Survey. The station is described in Water-Supply Paper No. 51, page 401. On February 18, 1901, erosion of a bar in the channel above the gage caused a division of the stream bed into two channels. On March 13, 1901, a permanent gage was placed farther downstream where the banks are more stable. The gage consists of a wooden rod driven vertically into the stream bed and spiked to a cottonwood tree on the left bank. The bench mark is on the top of a large bowlder 10 feet north of the gage, its elevation being 8.38 feet above the datum of gage. During 1901 the following measurements of discharge were made by C. V. and L. H. Taylor and A. H. Schadler.

List of discharge measurements of Carson River near Empire, Nev.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1900.	*Feet.*	*Sec.-ft.*	1901.	*Feet.*	*Sec.-ft.*
October 21	2.60	106	June 25	3.50	1,144
			July 10	2.80	677
1901.			July 24	2.00	384
February 20	4.00	1,689	August 12	1.20	130
March 13	2.75	608	November 8	1.55	190
May 21	4.40	2,351	December 16	1.70	242
June 3	4.00	1,709			

Daily gage height, in feet, of Carson River near Empire, Nev., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.50	2.50	3.25	2.30	3.85	3.85	3.40	1.40	0.30	0.80	1.50	2.00
2	2.40	2.45	3.30	2.30	3.60	4.00	3.20	1.40	.40	.90	1.50	1.80
3	2.40	2.40	3.15	2.30	3.25	4.15	3.10	1.30	.50	.90	1.50	1.80
4	2.35	2.50	3.10	2.20	3.20	4.20	3.00	1.30	.50	.90	1.50	2.10
5	2.50	2.40	2.95	2.20	3.30	4.30	2.90	1.40	.40	1.00	1.50	2.95
6	2.75	2.45	2.95	2.20	3.30	4.40	2.90	1.90	.40	1.00	1.50	2.00
7	3.15	2.40	3.00	2.20	3.45	4.25	2.90	1.90	.30	1.00	1.60	2.60
8	3.10	2.45	2.95	2.10	3.70	4.10	2.80	1.80	.30	1.00	1.60	2.20
9	2.60	2.40	2.90	2.10	3.70	4.00	2.70	1.70	.30	1.00	1.60	2.00
10	2.50	2.40	2.80	2.10	3.65	3.85	2.60	1.50	.40	1.00	1.50	2.00
11	2.50	2.45	2.80	2.00	4.00	3.70	2.60	1.40	.40	1.00	1.50	1.90
12	2.55	2.40	2.80	2.05	4.75	3.55	2.50	1.30	.40	1.00	1.50	1.70
13	2.50	2.35	2.80	2.20	5.05	3.45	2.40	1.10	.40	1.00	1.50	1.60
14	2.50	2.45	2.60	2.35	5.15	3.30	2.30	1.00	.40	1.00	1.50	1.80
15	2.50	2.60	2.60	2.55	5.20	3.35	2.20	.90	.40	1.00	1.50	2.00
16	2.50	2.60	2.60	2.80	5.10	3.40	2.20	.80	.40	1.00	1.50	1.90
17	2.50	3.85	2.60	2.75	5.10	3.55	2.10	.80	.40	1.00	1.50	1.80
18	2.50	4.50	2.60	2.70	5.25	3.60	2.00	.80	.50	1.00	1.50	1.75
19	2.50	3.85	2.50	2.85	5.15	3.60	1.90	1.00	.50	1.00	1.50	1.80
20	2.50	3.80	2.50	3.00	4.80	3.75	1.80	1.10	.40	1.00	1.50	1.80
21	2.50	4.00	2.50	3.15	4.35	3.75	1.70	1.20	.40	1.10	1.50	1.80
22	2.50	3.85	2.50	3.35	4.20	3.85	1.60	1.10	.40	1.10	1.50	1.80
23	2.50	3.50	2.50	3.30	3.95	3.80	1.50	1.10	.40	1.20	1.50	1.80
24	2.50	3.60	2.50	3.35	3.90	3.70	2.10	1.00	.50	1.20	1.50	1.80
25	2.50	3.45	2.50	3.50	3.90	3.50	2.00	.80	.60	1.20	1.50	1.60
26	2.50	3.15	2.50	3.55	3.80	3.30	1.90	.70	.70	1.20	1.50	1.80
27	2.50	3.05	2.50	3.60	3.70	3.20	1.80	.60	.80	1.30	1.50	1.60
28	2.50	3.15	2.40	3.50	3.65	3.10	1.70	.60	.80	1.40	1.60	1.80
29	2.50	.....	2.40	3.60	3.65	3.30	1.60	.60	.80	1.50	1.70	1.60
30	2.50	.....	2.40	3.75	3.60	3.50	1.50	.60	.80	1.60	1.90	1.60
31	2.50	.....	2.40	.....	3.75	.....	1.40	.50	.....	1.60	.....	1.60

TRUCKEE RIVER AT TAHOE, CAL.

This station, established by L. H. Taylor June 17, 1900, is located one-half mile below the town of Tahoe. It is described in Water-Supply Paper No. 51, page 402. The purpose of maintaining a station at this point is to determine the value of Lake Tahoe as a storage reservoir. Results of measurements for 1900 are published in the Twenty-second Annual Report, Part IV, page 403. The following measurements of discharge were made by C. V. Taylor during 1901:

List of discharge measurements of Truckee River at Tahoe, Cal.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1901.	*Feet.*	*Sec.-ft.*	1901.	*Feet.*	*Sec.-ft.*
September 5	1.94	386	November 11	1.57	296
September 12	1.85	356	Do	1.23	187
			Do	1.00	141

Daily gage height, in feet, of Truckee River at Tahoe, Cal., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	0.70	0.80	0.10	0.10	.....	1.20	1.65	1.95	1.65	1.65	1.25
2	.70	.80	.10	.10	.....	1.20	1.65	1.95	1.65	1.60	.95
3	.70	.80	.10	.10	.....	1.20	1.65	1.95	1.65	1.60	.95
4	.80	.80	.10	.10	.....	1.20	1.65	1.95	1.65	1.60	.95
5	.80	.80	.10	.10	.....	1.20	1.80	1.95	1.65	1.60	.95
6	.80	.80	.10	.10	.....	1.20	1.80	1.95	1.65	1.60	.95
7	.80	.90	.10	—.20	.....	1.20	2.00	1.90	1.60	1.60	.95
8	.80	.90	.10	—.20	.....	1.10	2.00	1.90	1.50	1.60	.95
9	.80	.90	.10	—.20	.....	1.10	2.00	1.90	1.70	1.60	.95
10	.90	.80	.10	—.20	.....	1.20	2.30	1.90	1.70	1.60	.95
11	.90	.80	.10	—.20	.....	1.20	2.35	1.90	1.65	1.60	.95
12	.90	.90	.10	—.20	.....	1.25	2.35	1.75	0.00	1.60	.80
13	.90	.90	.10	—.20	.....	1.25	2.35	1.75	1.65	1.60	.80
14	.90	.90	.10	([a])	.....	1.25	2.35	.90	1.65	1.60	.80
15	.90	.90	.10	.....	.....	1.25	2.35	1.40	1.65	1.60	.80
16	.80	.90	.10	.....	.....	1.25	2.35	1.70	1.60	1.60	.80
17	.80	.90	.10	.....	.....	1.25	2.35	1.70	1.60	1.60	.80
18	.80	.90	.10	.....	.....	1.25	2.35	1.70	1.60	1.60	.80
19	.80	.10	.10	.....	.....	1.60	1.95	1.70	1.60	1.60	.80
20	.80	.10	.10	.....	.....	1.60	1.95	1.70	1.60	1.25	.80
21	.80	.10	.10	.....	.....	1.60	1.95	1.70	1.60	1.25	.80
22	.80	.10	.10	.....	.....	1.60	1.55	1.70	1.60	1.25	.80
23	.80	.10	.10	.....	.....	1.60	1.95	1.70	1.70	1.25	.80
24	.80	.10	.10	.....	.....	1.60	1.95	1.70	1.70	1.25	.80
25	.80	.10	.10	.....	.....	1.65	1.95	1.70	1.70	1.25	.80
26	.80	.10	.10	.....	1.20	1.65	1.95	1.70	1.70	1.25	.80
27	.80	.10	.10	.....	1.20	1.65	1.95	1.70	1.65	1.25	.80
28	.80	.10	.10	.....	1.20	1.65	1.95	1.70	1.65	1.25	.80
29	.80	.....	.10	.....	1.20	1.65	1.95	1.65	1.65	1.25	.80
30	.80	.....	.10	.....	1.20	1.65	1.95	1.65	1.65	1.25	.80
31	.80	.....	.10	.....	.....	1.65	1.95	.....	1.65	.....	.80

[a] No flow from April 13 to June 26.

TRUCKEE RIVER AT NEVADA-CALIFORNIA STATE LINE.

The station was established by L. H. Taylor September 7, 1899, at the State line near Mystic, Cal., 17 miles west of Reno, Nev. A description of the station is given in Water-Supply Papers No. 38, page 331, and No. 51, page 403. Results of measurements for 1899 and 1900 will be found in the Twenty-second Annual Report, Part IV, page 404. During 1901 the following measurements of discharge were made by C. V. Taylor and A. H. Schadler:

List of discharge measurements of Truckee River at Nevada-California State line.

Date.	Gage height.	Discharge.	Date.	Gage height.	Gage height.
1901.	*Feet.*	*Sec. feet.*	1901.	*Feet.*	*Sec. feet.*
February 13	1.50	298	August 16	2.10	528
February 27	4.50	2,474	September 3	2.20	570
March 11	3.40	1,262	September 14	2.00	478
June 9	3.90	1,741	November 9	1.95	437
July 13	2.60	811	December 14	1.75	353

Daily gage height, in feet, of Truckee River at Nevada-California State line, for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.50	1.30	4.20	2.70	4.00	4.30	3.20	2.00	2.00	2.00	2.20	2.30
2	1.50	1.30	4.40	3.10	3.70	4.50	3.20	2.10	2.10	2.00	2.10	2.30
3	1.50	1.40	3.90	2.80	3.60	4.60	3.10	1.90	2.10	2.10	1.80	3.00
4	1.80	1.40	3.90	2.50	3.70	4.50	2.80	1.80	2.10	2.10	1.90	5.20
5	1.90	1.30	3.90	2.90	3.90	4.30	2.50	1.70	2.20	2.10	2.00	2.60
6	2.20	1.40	3.90	2.50	4.30	4.20	2.50	2.00	2.10	2.00	2.10	2.70
7	1.30	1.50	4.00	2.50	4.70	4.30	2.50	2.10	2.10	2.00	2.00	2.30
8	1.70	1.50	3.70	2.50	4.70	4.30	2.40	2.10	1.80	2.00	2.00	2.10
9	1.60	1.40	3.80	2.50	4.80	4.00	2.40	1.90	1.80	2.10	2.00	2.10
10	1.60	1.30	3.50	2.30	4.50	3.70	2.50	2.00	2.10	2.20	1.90	2.00
11	1.60	1.40	3.40	2.50	4.70	3.50	2.40	1.90	2.10	2.20	2.00	1.70
12	1.80	1.30	3.20	3.10	5.80	3.40	2.40	1.90	2.10	2.00	2.00	1.50
13	1.50	1.50	3.00	2.30	5.70	3.30	2.50	1.90	2.20	1.30	2.10	1.40
14	1.40	1.50	2.70	3.50	5.70	3.10	2.40	1.90	1.90	2.00	2.00	1.80
15	1.50	1.60	2.90	3.80	5.50	3.30	2.40	1.90	1.30	2.00	2.00	1.60
16	1.50	1.60	2.90	3.80	5.50	3.40	2.30	1.80	1.70	2.00	2.00	1.50
17	1.40	2.90	2.90	3.70	5.60	3.30	2.40	2.50	2.00	1.90	1.90	1.50
18	1.40	3.20	2.50	4.00	5.70	3.50	2.30	2.60	2.00	1.90	2.00	1.50
19	1.50	3.20	2.80	4.10	5.00	3.60	2.20	2.60	2.00	2.00	2.00	1.60
20	1.40	5.00	2.90	4.30	4.60	3.60	2.30	2.10	2.10	1.50	2.00	1.50
21	1.60	5.30	2.90	4.30	4.20	3.60	2.10	2.10	2.00	1.90	2.00	1.40
22	1.60	4.10	3.30	4.30	3.90	3.60	2.30	1.80	2.00	1.90	1.90	1.70
23	1.50	4.70	3.20	4.10	3.80	3.60	2.30	1.90	2.00	1.90	1.90	1.80
24	1.50	4.50	3.10	4.10	3.80	3.40	2.30	2.00	2.10	1.90	1.90	1.80
25	1.60	4.30	3.10	4.60	3.80	3.10	2.30	2.10	2.20	2.00	2.00	1.60
26	1.50	4.40	3.20	4.40	3.80	3.00	2.30	2.00	2.00	2.00	2.10	1.30
27	1.50	4.50	3.10	4.10	3.70	2.90	2.20	2.10	2.00	2.20	2.00	1.50
28	1.60	4.40	3.00	4.20	3.90	3.20	2.00	2.20	2.00	2.20	2.00	1.50
29	1.70	.....	2.70	4.30	3.80	3.30	2.30	2.00	2.00	2.20	2.20	1.50
30	1.40	.....	2.60	4.10	4.00	3.40	2.10	2.00	2.10	2.20	2.30	1.70
31	1.20	.....	2.70	.....	4.10	.....	1.90	2.10	.....	2.20	.....	1.50

TRUCKEE RIVER AT VISTA, NEV.

This station, established by L. H. Taylor August 18, 1899, is located 7 miles east of Reno, near the point where measurements were made in 1890, 1891, and 1892, the results of which are published in the Thirteenth Annual Report, Part III, page 95. It is described in Water-Supply Papers No. 38, page 331, and No. 51, page 404. A new bench mark was established March 14, 1901, on the top of a 2 by 2 inch plug driven 2 feet into the ground at the upper end of the inclined gage on the left bank. Its elevation is 9.60 feet above the datum of the gage. Results of measurements for 1899 and 1900 will be found in the Twenty-second Annual Report, Part IV, page 405. During 1901 the following measurements were made by C. V. and L. H. Taylor:

List of discharge measurements of Truckee River at Vista, Nev.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1901.	*Feet.*	*Sec. feet.*	1901.	*Feet.*	*Sec. feet.*
February 22	6.35	3,077	August 15	2.20	198
March 14	3.85	[a] 899	September 2	2.50	325
March 20	3.88	[a] 911	September 14	2.40	276
June 21	4.10	1,165	November 13	3.05	584
July 12	2.70	417	December 15	2.78	448

[a] Results too small.

Daily gage height, in feet, of Truckee River at Vista, Nev., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.55	2.75	5.65	3.70	4.90	5.20	3.65	2.25	2.40	2.70	3.00	3.30
2	3.55	2.80	5.40	4.00	4.80	5.30	3.80	2.20	2.50	2.70	3.00	3.30
3	4.65	2.80	5.45	3.80	4.60	5.30	3.20	2.35	2.50	2.70	3.00	3.40
4	4.40	2.80	5.15	3.95	4.60	5.20	3.30	2.40	2.50	2.80	3.00	3.60
5	4.25	2.70	5.20	3.70	4.60	5.00	3.35	2.85	2.50	2.75	3.00	4.30
6	4.20	2.85	5.00	3.65	4.80	4.70	3.25	2.70	2.50	2.80	3.00	3.30
7	3.90	2.75	4.90	3.60	5.30	5.00	2.90	2.55	2.50	2.75	3.00	3.00
8	3.25	2.80	5.10	3.60	5.30	5.00	2.85	2.60	2.45	2.80	2.90	3.00
9	3.10	2.70	4.70	3.35	6.00	4.90	2.85	2.40	2.50	2.80	2.90	3.00
10	3.10	2.80	4.60	3.35	6.00	4.00	2.95	2.30	2.45	2.75	2.95	3.00
11	3.10	2.75	4.10	3.55	6.95	4.10	2.85	2.10	2.45	3.00	2.90	3.00
12	3.20	2.80	4.15	3.70	6.70	4.10	3.15	2.20	2.40	2.90	2.90	2.70
13	2.95	2.80	4.60	4.00	6.50	4.10	3.00	2.35	2.40	2.80	2.90	2.70
14	2.95	2.80	3.90	4.40	6.65	4.00	2.80	2.55	2.40	2.75	2.90	2.80
15	2.95	2.80	3.90	4.70	6.35	3.90	2.60	2.05	2.35	2.70	2.95	2.75
16	2.80	4.70	3.95	4.85	6.45	3.75	2.60	2.85	2.40	2.80	2.90	2.70
17	2.75	5.85	3.75	4.85	6.00	3.75	2.55	2.85	2.55	2.75	2.95	2.60
18	2.70	5.20	3.75	4.90	5.60	3.75	2.65	2.85	2.40	2.80	2.90	2.60
19	2.70	5.20	3.80	5.00	5.60	4.15	2.55	2.85	2.40	2.75	2.90	2.60
20	2.80	5.25	3.70	5.30	5.10	4.00	2.55	2.85	2.40	2.80	2.95	2.70
21	2.95	6.75	3.90	5.00	5.05	3.85	2.10	2.55	2.40	2.80	2.95	2.70
22	2.95	6.95	3.95	5.20	4.90	4.00	2.15	2.55	2.40	2.60	2.95	2.70
23	2.75	6.20	4.30	5.00	4.70	4.00	2.15	2.55	2.40	2.60	2.95	2.75
24	2.75	6.10	4.00	5.00	4.50	3.85	2.20	2.50	2.80	2.70	2.80	2.60
25	2.90	6.20	4.10	5.00	4.50	3.55	2.20	2.30	2.80	2.80	2.95	2.60
26	2.85	6.40	4.20	5.30	4.50	3.55	2.20	2.30	2.80	2.80	3.10	2.60
27	2.70	6.30	4.00	5.20	4.55	3.85	2.30	2.35	2.80	2.85	2.95	2.60
28	2.80	6.40	3.95	5.00	5.20	3.75	2.20	3.45	2.70	3.30	3.00	2.60
29	2.95	.....	3.80	5.10	5.25	3.65	2.30	2.35	2.70	3.20	3.60	2.70
30	2.90	.....	3.75	4.85	5.25	3.80	2.25	2.30	2.70	3.15	3.30	2.70
31	2.75	.....	3.80	.....	5.00	.....	2.20	2.40	.....	3.10	.....	2.50

STEAMBOAT CREEK AT STEAMBOAT SPRINGS, NEVADA.

The station was established May 31, 1900, for the purpose of ascertaining the volume of water entering Reno Valley. It is described in Water-Supply Paper No. 51, page 406. On January 4, 1901, the gage was changed and its datum lowered 0.3 feet. The station was discontinued on June 30, 1901. Results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 406. During the year the following measurements were made by C. V. and L. H. Taylor:

List of discharge measurements of Steamboat Creek at Steamboat Springs, Nevada.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1901.	*Feet.*	*Sec.-ft.*	1901.	*Feet.*	*Sec.-ft.*
February 14 [a]	0.80	8	May 15	1.50	30
February 18	1.00	12	June 6	1.20	17
March 19	.80	7			

[a] Approximate.

Daily gage height in feet of Steamboat Creek at Steamboat Springs, Nevada, for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May	June.	Day.	Jan.	Feb.	Mar.	Apr.	May	June.
1	0.60	0.80	1.20	0.80	1.20	1.30	17	0.70	2.00	0.90	0.90	1.50	1.50
2	.60	.80	1.20	.80	1.00	1.30	18	.65	1.00	.90	.90	1.50	1.60
3	.60	.80	1.20	.80	1.00	1.30	19	.60	1.00	.80	.90	1.50	1.70
4	1.00	.80	1.10	.80	1.00	1.30	20	.80	1.30	.80	.80	1.50	1.70
5	1.00	.75	1.10	.70	1.00	1.30	21	.80	1.40	.80	.90	1.50	1.70
6	2.00	.75	1.10	.70	1.00	1.20	22	.70	1.30	.80	.90	1.50	1.60
7	.85	.75	1.10	.70	1.00	1.20	23	.70	1.30	.70	.90	1.50	1.60
8	.75	.75	1.10	.70	1.00	1.20	24	.70	1.60	.70	.90	1.40	1.60
9	.75	.75	1.00	.70	1.00	1.30	25	.75	1.50	.70	.90	1.40	1.70
10	.70	.70	1.10	.60	1.20	1.30	26	.80	1.30	.70	.90	1.40	1.70
11	.70	.60	1.30	.60	1.20	1.50	27	.85	1.20	.70	.90	1.40	1.70
12	.70	.60	1.20	.60	1.20	1.50	28	.85	1.20	.80	.90	1.40	1.70
13	.70	.60	1.10	.90	1.20	1.50	29	.85	.....	.80	.90	1.40	1.70
14	.70	.65	1.10	1.00	1.40	1.50	30	.80	.....	.80	1.00	1.40	1.70
15	.70	.75	1.00	1.00	1.50	1.50	31	.80	.....	.80	.....	1.30	.....
16	.75	2.25	1.00	.90	1.50	1.50							

WILLOW CREEK NEAR STANDISH, CAL.

This station, established by L. H. Taylor on June 4, 1900, is at the highway bridge about 4 miles west of north from the post-office at Standish, and about 1½ miles north of Susan River. It is described in Water-Supply Paper No. 51, page 407. No measurements were made of the discharge of this stream during the year 1901, and the station was discontinued on December 31.

Daily gage height, in feet, of Willow Creek near Standish, Cal., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4.30	4.40	7.50	4.50	4.00	3.70	3.90	3.55	3.50	4.30	4.35	5.60
2	4.00	4.40	7.40	4.55	4.00	3.70	3.90	3.55	4.20	4.30	4.35	5.60
3	3.90	4.00	7.40	4.55	4.10	3.70	3.60	3.55	4.00	4.30	4.35	5.60
4	3.90	4.00	7.20	4.50	4.10	3.70	3.60	3.55	3.90	4.20	4.35	5.70
5	3.90	3.90	7.00	4.50	4.10	3.60	3.60	3.55	3.90	4.20	4.35	5.80
6	3.90	3.90	7.00	4.50	4.10	3.60	3.60	3.55	3.90	4.20	4.35	6.00
7	3.90	3.90	6.90	4.50	4.00	3.60	3.60	3.55	4.00	4.30	4.35	6.00
8	3.90	3.90	6.80	4.20	4.00	3.60	3.60	3.55	4.30	4.30	4.35	6.00
9	3.90	3.90	6.80	4.20	4.00	3.60	3.60	3.55	4.30	4.30	4.35	6.00
10	3.90	3.90	6.80	4.20	4.00	3.60	3.70	3.55	4.00	4.30	4.35	5.70
11	3.90	3.80	6.80	4.00	3.90	3.60	3.70	3.55	3.80	4.30	4.35	5.70
12	3.90	3.80	6.60	4.00	3.90	3.60	3.70	3.55	3.80	4.30	4.35	5.60
13	4.20	3.80	6.60	4.00	3.90	3.60	3.70	3.55	3.80	4.30	4.35	5.60
14	4.40	3.90	6.60	4.00	3.90	3.60	3.70	3.55	3.80	4.30	4.35	5.60
15	4.60	3.90	6.60	4.00	3.80	3.60	3.70	3.55	3.80	4.30	4.35	5.60
16	4.90	3.90	6.60	4.00	3.80	3.60	3.70	3.55	3.80	4.35	4.35	5.60
17	4.60	5.80	5.40	4.00	3.80	3.60	3.70	3.55	3.80	4.35	4.70	5.60
18	4.60	5.80	5.40	4.00	3.80	3.60	3.70	3.55	3.80	4.35	4.70	5.60
19	4.60	8.00	5.20	4.00	3.80	3.65	3.70	3.55	3.80	4.35	4.70	5.00
20	4.60	8.00	5.20	4.00	3.70	3.65	3.70	3.55	3.80	4.35	4.70	5.00
21	4.60	8.40	4.80	4.00	3.70	3.65	3.70	3.55	3.80	4.35	4.70	5.00
22	4.90	8.40	4.80	4.00	3.60	3.65	3.70	3.55	3.80	4.35	4.70	5.00
23	5.00	8.20	4.80	4.00	3.60	3.65	3.70	3.55	3.90	4.70	4.75	5.00
24	5.20	8.20	4.80	3.00	3.85	3.65	3.70	3.55	3.90	4.70	4.75	5.00
25	4.90	8.00	4.60	3.40	3.85	3.65	3.70	3.55	3.90	5.00	4.75	4.00
26	4.65	7.90	4.60	3.60	3.70	3.65	3.80	3.55	3.90	5.00	4.75	4.00
27	4.60	7.80	4.60	3.90	3.70	3.65	3.80	3.50	3.90	5.00	5.00	4.00
28	4.60	7.60	4.50	4.25	3.70	4.60	3.80	3.50	4.00	4.90	5.60	4.00
29	4.50	.....	4.50	4.25	3.70	3.90	3.80	3.50	4.00	4.90	5.60	4.00
30	4.40	.....	4.50	4.00	3.70	3.90	3.00	3.50	4.00	4.70	5.60	4.00
31	4.40	.....	4.50	.....	3.70	.....	3.40	3.50	.....	4.35	.....	4.00

SUSAN RIVER NEAR SUSANVILLE, CAL.

This station is about three-fourths of a mile southwest of the town, at the electric-light plant. It was established by L. H. Taylor, June

3, 1900, and is described in Water-Supply Paper No. 51, page 408. A short distance above the station a small irrigating ditch, known as the "Masten ditch," is taken out on the right bank of the stream. Near its head is a flume in which a gage has been placed from which the gage record here given has been obtained. During 1901 measurements were made of the discharge of the river at Susanville, under the direction of L. H. Taylor, as follows:

List of discharge measurements of Susan River near Susanville, Cal.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1901.	*Feet.*	*Sec.-ft.*	1901.	*Feet.*	*Sec.-ft.*
March 16	4.30	274	May 20	4.50	351
April 5	4.00	178	June 7	3.60	84

Daily gage height, in feet, of Susan River near Susanville, Cal., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.20	3.10	5.55	4.10	4.90	3.92	2.65	2.25	2.25	2.20	2.40	3.05
2	3.20	3.10	5.45	4.15	4.88	3.90	2.75	2.25	2.25	2.45	2.35	3.50
3	3.20	3.10	5.05	4.07	4.87	3.85	2.80	2.20	2.20	2.40	2.35	3.76
4	3.20	3.10	4.95	4.00	4.85	3.80	2.75	2.20	2.20	2.30	2.35	4.05
5	3.20	3.10	4.90	4.00	4.85	3.72	2.70	2.20	2.20	2.30	2.35	4.80
6	3.30	3.10	4.90	4.00	4.93	3.65	2.70	2.15	2.15	2.30	2.35	4.25
7	3.30	3.10	5.00	3.90	4.95	3.63	2.60	2.15	2.15	2.30	2.35	3.85
8	3.30	3.10	4.75	3.85	5.00	3.55	2.50	2.15	2.15	2.30	2.35	3.72
9	3.25	3.10	4.75	3.80	5.00	3.50	2.55	2.15	2.15	2.30	2.35	3.50
10	3.25	3.10	4.55	3.80	5.05	3.40	2.83	2.10	2.15	2.30	2.35	3.37
11	3.25	3.10	4.50	3.90	5.08	3.30	2.85	2.30	2.10	2.30	2.35	3.00
12	3.25	3.10	4.45	4.13	5.07	3.25	2.85	2.50	2.10	2.30	2.40	2.92
13	3.20	3.10	4.20	4.35	5.10	3.20	2.83	2.50	2.10	2.30	2.40	2.85
14	3.20	3.20	4.25	4.60	5.10	3.15	2.80	2.50	2.10	2.30	2.40	2.80
15	3.20	3.30	4.30	4.75	5.00	3.15	2.80	2.50	2.10	2.30	2.40	2.75
16	3.20	3.70	4.20	4.70	4.95	3.10	2.80	2.45	2.15	2.30	2.40	2.75
17	3.20	4.85	4.20	4.75	4.90	3.10	2.80	2.50	2.05	2.30	2.40	2.70
18	3.20	4.15	4.15	4.80	4.83	3.10	2.80	2.45	2.05	2.30	2.40	2.70
19	3.20	4.05	4.15	4.97	4.72	3.05	2.78	2.45	2.05	2.30	2.40	2.65
20	3.20	5.95	4.15	5.05	4.58	3.00	2.75	2.40	2.05	2.30	2.40	2.60
21	3.20	5.10	4.22	5.05	4.45	2.95	2.70	2.40	2.05	2.30	2.45	2.60
22	3.15	4.80	4.30	5.05	4.20	2.90	2.70	2.40	2.15	2.30	2.45	2.55
23	3.15	6.30	4.23	4.95	4.25	2.85	2.70	2.40	2.25	2.30	2.50	2.55
24	3.10	5.85	4.25	4.90	4.20	2.80	2.70	2.40	2.30	2.35	2.55	2.50
25	3.10	5.65	4.55	5.00	4.25	2.80	2.68	2.35	2.25	2.35	2.60	2.50
26	3.10	5.20	4.50	4.95	4.13	2.75	2.63	2.40	2.20	2.40	2.80	2.50
27	3.10	5.60	4.45	4.87	4.10	2.70	2.53	2.35	2.20	2.40	2.70	2.45
28	3.10	5.70	4.40	4.78	4.05	2.70	2.43	2.30	2.20	2.65	3.60	2.45
29	3.10	.....	4.25	5.45	4.05	2.65	2.40	2.30	2.20	2.50	3.65	2.40
30	3.10	.....	4.18	4.97	4.00	2.60	2.35	2.30	2.20	2.50	3.25	2.40
31	3.10	.....	4.05	.....	3.95	.....	2.30	2.30	.....	2.50	.....	2.40

Daily gage height, in feet, of Masten ditch near Susanville, Cal., for 1901.

Day.	July.	Aug.	Sept.	Oct.	Nov.	Day.	July.	Aug.	Sept.	Oct.	Nev.
1		0.80	0.80	0.90	0.80	17		1.10	0.90	0.80	0.80
2		.80	.75	1.05	.80	18		1.10	.90	.80	.80
3		.80	.85	1.00	.80	19		1.10	.90	.80	.80
4		.80	.85	.80	.70	20		1.10	.90	.80	.80
5		.80	.80	.80	.70	21		1.10	.90	.80	.80
6		.90	.80	.80	.70	22		.80	1.00	.80	.90
7		.90	.80	.80	.70	23		.80	.95	.80	.90
8		.90	.80	.80	.70	24		.80	.95	.80	.90
9		.80	.85	.80	.70	25		.80	.95	.80	.90
10		.70	.85	.80	.70	26	1.10	.80	.90	.80	1.00
11		1.10	.90	.80	.80	27		.80	.80	.90	.80
12		1.10	.90	.80	.80	28		.60	.80	.90	.90
13		1.10	.90	.80	.80	29		.40	.80	.90	.90
14		1.10	.90	.80	.80	30		.40	.80	.90	.80
15		1.10	.85	.80	.80	31		.40	.80		.80
16		1.10	.90	.80	.80						

BEAR RIVER AT BATTLECREEK, IDAHO.

This station, established October 11, 1889, is about 10 miles north of the Utah-Idaho boundary line, and is described in Water-Supply Paper No. 51, page 409. The station is of considerable importance from the fact that its location is near the Utah-Idaho line, and the measurements there will indicate the volume of water that passes from Idaho into Utah. During 1901 a large canal was completed, appropriating the waters of the Bear about 8 miles below Soda Springs in sufficient quantity to irrigate about 35,000 acres of very fine land in that locality. Results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 407. During 1901 the following measurements were made by G. L. Swendsen:

List of discharge measurements of Bear River at Battlecreek, Idaho.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1901.	*Feet.*	*Sec.-ft.*	1901.	*Feet.*	*Sec.-ft.*
January 30	1.66	594	June 25	1.90	721
February 23	2.50	853	July 27	1.40	419
March 25	2.35	842	August 22	1.50	490
April 22	3.30	2,128	September 16	1.40	435
Do	3.30	2,001	November 18	1.65	611
May 13	3.97	2,350	December 16	1.75	526

Daily gage height, in feet, of Bear River at Battlecreek, Idaho, for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.55	1.55	2.43	2.40	3.80	3.70	1.85	1.30	1.35	1.50	1.70	1.70
2	1.55	1.55	2.55	2.40	3.88	3.72	1.77	1.30	1.35	1.50	1.70	1.70
3	1.55	1.55	2.55	2.40	3.93	3.65	1.75	1.30	1.30	1.50	1.70	1.80
4	1.55	1.55	2.55	2.40	4.13	3.58	1.70	1.30	1.30	1.50	1.70	1.90
5	1.55	1.55	2.55	2.40	4.25	3.53	1.68	1.30	1.30	1.50	1.70	1.90
6	1.55	1.55	2.55	2.40	4.15	3.45	1.65	1.30	1.30	1.50	1.70	1.90
7	1.55	1.55	2.60	2.40	4.20	3.40	1.65	1.30	1.30	1.50	1.70	1.90
8	1.55	1.55	2.60	2.40	4.20	3.35	1.63	1.35	1.30	1.50	1.70	1.90
9	1.55	1.55	2.65	2.40	4.20	3.28	1.60	1.35	1.35	1.50	1.70	1.90
10	1.55	1.55	2.75	2.40	4.15	3.13	1.60	1.35	1.35	1.50	1.70	1.90
11	1.55	1.55	2.77	2.40	4.22	3.00	1.57	1.35	1.35	1.50	1.70	1.90
12	1.55	1.55	2.87	2.43	4.25	2.90	1.55	1.35	1.40	1.50	1.70	1.90
13	1.55	1.55	2.98	2.50	4.20	2.75	1.55	1.35	1.40	1.50	1.70	1.90
14	1.55	1.55	2.95	2.77	4.12	2.60	1.55	1.35	1.40	1.50	1.70	1.90
15	1.55	1.55	2.82	2.90	4.00	2.55	1.53	1.35	1.40	1.50	1.55	1.90
16	1.55	1.55	2.73	3.00	4.05	2.48	1.50	1.35	1.40	1.55	1.60	1.90
17	1.55	1.55	2.63	3.10	4.10	2.42	1.47	1.38	1.40	1.55	1.60	1.83
18	1.55	1.55	2.50	3.15	4.10	2.40	1.45	1.40	1.40	1.55	1.60	1.73
19	1.55	1.55	2.43	3.20	4.10	2.37	1.45	1.40	1.40	1.58	1.60	1.63
20	1.55	1.55	2.40	3.28	4.10	2.35	1.43	1.40	1.40	1.60	1.60	1.60
21	1.55	2.93	2.40	3.30	4.10	2.35	1.40	1.40	1.40	1.60	1.65	1.60
22	1.55	2.66	2.40	3.35	4.05	2.35	1.40	1.40	1.50	1.60	1.65	1.60
23	1.60	2.40	2.40	3.37	4.05	2.30	1.38	1.40	1.50	1.60	1.70	1.60
24	1.60	2.03	2.40	3.43	3.98	2.28	1.35	1.40	1.50	1.60	1.70	1.60
25	1.60	2.08	2.40	3.47	3.92	2.18	1.35	1.35	1.50	1.60	1.70	1.60
26	1.60	2.22	2.40	3.65	3.90	2.15	1.35	1.35	1.50	1.60	1.70	1.60
27	1.60	2.33	2.40	3.82	3.93	2.08	1.35	1.35	1.50	1.70	1.70	1.60
28	1.60	2.40	2.40	3.85	3.95	2.00	1.35	1.35	1.50	1.70	1.70	1.60
29	1.60	------	2.40	3.90	3.93	2.00	1.33	1.35	1.50	1.70	1.70	1.60
30	1.58	------	2.40	3.85	3.90	1.95	1.30	1.35	1.50	1.70	1.70	1.60
31	1.55	------	2.40	------	3.80	------	1.30	1.35	------	1.70	------	1.60

CUB RIVER AT FRANKLIN, IDAHO.

This gaging station, established July 23, 1900, is a short distance above the head gates of the Lewiston canal, and is described in Water-Supply Paper No. 51, page 410. Results of measurements for 1900 are published in the Twenty-second Annual Report, Part IV, page 408. The station was discontinued during the early part of 1901. A measurement was made by G. L. Swendsen January 21, 1901, when the discharge was 47 second-feet and the gage height 1.50 feet.

LOGAN RIVER NEAR LOGAN, UTAH.

This station, established June 1, 1896, is in the river canyon about 2 miles east of Logan and is described in Water-Supply Paper No. 51, page 411. During the low-water season the entire supply of the river is used for irrigation. Within the last two years it has become very prominent as a source of water power, and a large electric plant utilizing the entire low-water supply under a head of 220 feet furnishes power to Salt Lake City and a number of the large mining camps of the State. It is operated on the same circuit and in conjunction with a similar plant on the Provo River.

A study of the results on the Logan River for a period of four or five years shows a remarkable decrease in the low-water discharge and a change in the occurrence of maximum flow from late in June to the middle of May. The entire watershed is a public range, and by the unrestricted grazing of thousands of sheep has been stripped of nearly all its vegetation, destroying many of nature's provisions for water preservation. With present conditions continued great injury to irrigation interests is sure to result.

Results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 408.

During 1901 the following measurements of discharge were made by G. L. Swendsen:

List of discharge measurements of Logan River near Logan, Utah.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1901.	*Feet.*	*Sec.-ft.*	1901.	*Feet.*	*Sec.-ft.*
January 23	2.55	161	July 30	2.80	174
February 20	2.60	166	August 21	2.82	184
March 19	2.42	140	September 7	2.81	262
April 29	3.30	400	October 25	2.70	198
May 25	4.03	861	November 25	2.65	176
June 23	3.50	332	December 22 [a]	2.60	476

[a] Exclusive of water used by Hercules Power Company. Total discharge, 155.

Daily gage height, in feet, of Logan River near Logan, Utah, for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	2.60	2.50	2.60	2.50	3.40	4.00	...	2.95	2.85	2.80	2.70
2	2.60	2.50	2.60	2.55	3.40	4.00	...	2.95	2.80	2.75	2.70
3	2.60	2.50	2.60	2.55	3.35	4.00	...	2.95	2.80	2.75	2.70
4	2.60	2.50	2.60	2.55	3.35	3.90	...	2.95	2.80	2.75	2.70
5	2.60	2.50	2.60	2.55	3.40	3.90	...	2.95	2.80	2.75	2.70
6	2.60	2.50	2.60	2.55	3.40	3.90	...	2.95	2.80	2.75	2.70
7	2.60	2.50	2.60	2.55	3.40	3.85	...	2.95	2.80	2.75	2.70
8	2.50	2.50	2.60	2.55	3.45	3.85	...	2.90	2.80	2.75	2.70
9	2.70	2.50	2.60	2.55	3.60	3.85	3.15	2.90	2.80	2.75	2.70
10	2.55	2.50	2.60	2.60	3.85	3.80	3.15	2.90	2.80	2.75	...
11	2.60	2.50	2.55	2.60	3.90	3.80	3.10	2.90	2.80	2.75	...
12	2.60	2.50	2.55	2.60	4.00	3.75	3.10	2.90	2.80	2.75	...
13	2.55	2.50	2.55	2.70	4.10	3.75	3.10	2.90	2.80	2.75	...
14	2.55	2.50	2.50	2.70	4.30	3.75	3.05	2.90	2.80	2.75	...
15	2.55	2.50	2.50	2.70	4.40	3.70	3.05	2.90	2.80	2.75	...
16	2.50	2.55	2.50	2.80	4.45	3.70	3.05	2.90	2.80	2.75	...
17	2.50	2.55	2.50	2.80	4.50	3.70	3.05	2.90	2.80	2.75	...
18	2.50	2.55	2.50	2.85	4.60	3.65	3.05	2.90	2.80	2.75	...
19	2.50	2.55	2.50	2.85	4.70	3.65	3.00	2.90	2.80	2.75	...
20	2.55	2.55	2.50	2.90	4.70	3.60	3.00	2.85	2.80	2.75	...
21	2.55	2.55	2.50	3.00	4.60	3.60	3.00	2.85	2.80	2.75	...
22	2.55	2.55	2.50	3.05	4.40	3.60	3.00	2.85	2.80	2.70	...
23	2.55	2.55	2.50	3.10	4.20	3.55	3.00	2.85	2.80	2.70	...
24	2.55	2.55	2.50	3.20	4.05	3.55	3.00	2.85	2.80	2.70	...
25	2.55	2.55	2.50	3.30	4.10	3.55	3.00	2.85	2.80	2.70	...
26	2.55	2.60	2.50	3.20	4.20	3.50	2.95	2.85	2.80	2.70	...
27	2.55	2.60	2.50	3.30	4.30	3.50	2.95	2.85	2.80	2.70	...
28	2.50	2.60	2.50	3.10	4.20	(a)	2.95	2.85	2.80	2.70	...
29	2.50	...	2.50	3.20	4.20	...	2.95	2.85	2.80	2.70	...
30	2.40	...	2.50	3.40	4.20	...	2.95	2.85	2.80	2.70	...
31	2.45	...	2.50	...	4.10	...	2.95	2.85	...	2.70	...

a Gage washed out.

BLACKSMITH FORK AT HYRUM, UTAH.

This station was established by George L. Swendsen July 19, 1900. It is near the tollgate at the mouth of the canyon and is described in Water-Supply Paper No. 51, page 412. Six irrigation canals and one large power plant are supplied by this river, and during the irrigation season the entire flow is utilized. Within the last year another canal has been built from this stream, and a great interest has been taken in relation to investigations for reservoirs to supply the shortage of water in August and September. Results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 409. During 1901 the following measurements were made by G. L. Swendsen and W. D. Beers:

List of discharge measurements of Blacksmith Fork at Hyrum, Utah.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1901.	*Feet.*	*Sec.-ft.*	1901.	*Feet.*	*Sec.-ft.*
January 26	2.88	106	August 26	3.10	111
February 27	3.00	118	September 28	3.00	132
March 22	2.90	117	October 26	3.00	121
April 27	3.60	347	November 25	2.95	107
June 24	3.30	192	December 23	2.95	126
July 19	3.10	133			

Daily gage height, in feet, of Blacksmith Fork at Hyrum, Utah, for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.80	2.80	3.20	2.90	3.40	3.60	3.20	3.20	3.10	3.00	3.00	3.00
2	2.90	2.90	3.20	2.90	3.50	3.50	3.20	3.20	3.10	3.00	3.00	3.00
3	3.05	2.90	3.20	2.90	3.40	3.50	3.20	3.20	3.10	3.00	3.00	3.00
4	3.00	2.90	3.10	2.90	3.50	3.30	3.20	3.20	3.10	3.00	3.00	3.00
5	3.00	2.90	3.10	2.90	3.50	3.20	3.20	3.20	3.10	3.00	3.00	3.00
6	3.00	2.90	3.10	2.90	3.50	3.30	3.20	3.20	3.10	3.00	3.00	3.00
7	3.00	2.80	3.20	2.90	3.50	3.40	3.20	3.20	3.10	3.00	3.00	3.00
8	3.05	2.80	3.10	2.90	3.40	3.50	3.20	3.10	3.10	3.00	3.00	3.00
9	2.90	2.90	3.10	2.90	3.30	3.40	3.10	3.10	3.00	3.00	3.00	3.00
10	2.90	2.90	3.00	3.00	3.20	3.40	3.10	3.10	3.00	3.00	3.00	3.00
11	3.00	2.80	2.90	3.00	3.20	3.30	3.10	3.10	3.00	3.00	3.00	3.00
12	3.00	2.80	2.90	3.10	3.20	3.30	3.10	3.10	3.00	3.00	3.00	3.00
13	3.00	2.90	2.90	3.20	3.10	3.40	3.10	3.10	3.00	3.00	3.00	3.00
14	3.00	2.90	2.90	3.20	3.00	3.20	3.10	3.10	3.00	3.00	3.00	3.00
15	3.00	2.90	2.90	3.20	3.00	3.20	3.10	3.10	3.00	3.00	3.00	3.00
16	3.00	2.90	2.90	3.20	3.10	3.20	3.10	3.10	3.00	3.00	3.00	3.00
17	2.90	2.80	2.90	3.20	3.00	3.20	3.10	3.10	3.00	3.00	3.00	3.00
18	2.90	2.80	2.90	3.30	3.00	3.20	3.10	3.10	3.00	3.00	3.00	3.00
19	2.90	2.90	2.90	3.30	3.10	3.20	3.10	3.10	3.00	3.00	3.00	3.00
20	2.90	2.90	2.90	3.30	3.00	3.20	3.10	3.20	3.00	3.00	3.00	3.00
21	2.90	3.00	2.90	3.10	2.90	3.20	3.10	3.20	3.00	3.00	3.00	3.00
22	2.90	2.90	2.90	3.10	2.90	3.20	3.10	3.10	3.00	3.00	3.00	3.00
23	2.90	2.90	2.90	3.20	2.90	3.20	3.10	3.10	3.00	3.00	3.00	3.00
24	2.90	3.00	2.90	3.20	3.00	3.20	3.10	3.10	3.00	3.00	3.00	3.00
25	2.90	2.90	2.90	3.10	2.90	3.20	3.10	3.10	3.00	3.00	3.00	3.00
26	2.90	3.00	2.90	3.20	2.90	3.20	3.10	3.10	3.00	3.00	3.00	3.00
27	2.90	3.10	2.90	2.90	2.80	3.20	3.10	3.10	3.00	3.00	3.00	3.00
28	2.90	3.10	2.90	2.90	2.90	3.20	3.10	3.10	3.00	3.50	3.00	3.00
29	2.90	.....	2.90	3.00	3.40	3.20	3.10	3.10	3.00	3.50	3.00	2.92
30	2.80	.....	2.90	2.90	3.50	3.20	3.10	3.10	3.00	3.00	3.00	2.92
31	2.90	.....	2.90	.....	3.90	.....	3.10	3.10	.....	3.00	.....	2.90

BEAR RIVER NEAR COLLINSTON, UTAH.

This station, established July 1, 1889, is about 4 miles above the railroad station at Collinston, 2 miles east of the town of Fielding, Utah, and below the headworks of the Bear River canal. It is described in Water-Supply Paper No. 51, page 413. A canal, now nearly completed, will divert water a considerable distance above the Battlecreek station to irrigate a large tract of land on the west side of Cache Valley. Its operations will greatly modify the discharge at the Collinston station during the next season. During the last year the discharge at this station reached the lowest stage on record, less than one-half the minimum for the preceding year. Work is progressing very rapidly on the east branch of the Bear River canal, and its appropriation will entirely exhaust the low-water supply of the Bear at this point. Results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 410. During 1901 the following discharge measurements were made by G. L. Swendsen:

List of discharge measurements of Bear River near Collinston, Utah.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1901.	*Feet.*	*Sec.-ft.*	1901.	*Feet.*	*Sec.-ft.*
February 18	1.80	1,415	August 30	0.95	377
May 27	4.22	4,274	September 14	.90	392
July 31	.52	264	October 21	1.50	973

Daily gage height, in feet, of Bear River near Collinston, Utah, for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.35	1.70	3.30	2.25	3.85	3.90	1.45	0.50	0.95	1.30	1.60	1.75
2	1.35	1.60	3.30	2.25	3.90	3.75	1.40	.50	.95	1.30	1.55	1.75
3	1.50	1.60	2.90	2.25	4.10	3.70	1.40	.50	.90	1.35	1.55	1.85
4	1.60	1.75	2.70	2.30	4.20	3.60	1.30	.50	.90	1.40	1.55	1.85
5	1.75	1.80	2.50	2.30	4.50	3.50	1.20	.55	.95	1.40	1.55	1.95
6	1.85	1.80	2.50	2.25	4.80	3.40	1.20	.60	.95	1.45	1.50	1.90
7	2.10	1.80	2.50	2.30	4.70	3.30	1.15	.65	.95	1.50	1.50	1.90
8	2.00	1.75	2.50	2.30	4.70	3.25	1.15	.70	.95	1.50	1.55	1.80
9	1.95	1.70	2.50	2.30	4.70	3.10	1.15	.70	.90	1.50	1.55	1.80
10	1.85	1.60	2.60	2.30	4.70	2.90	1.10	.70	.90	1.45	1.60	1.70
11	1.70	1.60	2.80	2.30	4.70	2.75	1.10	.70	.90	1.45	1.65	1.65
12	1.70	1.60	2.90	2.30	4.75	2.65	1.05	.70	.90	1.45	1.65	1.60
13	1.80	1.60	3.00	2.40	4.75	2.50	1.05	.70	.90	1.45	1.70	1.55
14	1.90	1.60	2.90	2.60	4.75	2.40	1.00	.70	.90	1.45	1.70	1.50
15	1.90	1.65	2.80	2.80	4.75	2.30	1.00	.75	.95	1.50	1.65	1.50
16	1.80	1.80	2.70	3.00	4.75	2.20	1.00	.80	.95	1.50	1.65	1.55
17	1.80	1.80	2.60	3.00	4.75	2.10	1.00	.80	1.15	1.50	1.65	1.65
18	1.75	1.80	2.50	3.00	4.75	2.50	.95	.85	1.15	1.50	1.70	1.70
19	1.65	1.80	2.40	3.00	4.80	2.00	.95	.90	1.05	1.50	1.70	1.70
20	1.65	1.80	2.30	3.00	4.75	2.00	.90	.95	1.05	1.50	1.70	1.90
21	1.70	2.10	2.30	3.20	4.80	2.00	.90	1.05	1.05	1.50	1.70	1.60
22	1.70	3.10	2.30	3.30	4.75	1.95	.85	1.01	1.05	1.50	1.70	1.60
23	1.75	3.30	2.30	3.40	4.60	1.90	.85	1.01	1.10	1.50	1.70	1.75
24	1.75	3.00	2.30	3.40	4.50	1.90	.80	1.01	1.20	1.50	1.70	1.80
25	1.80	2.90	2.30	3.60	4.40	1.80	.75	.95	1.25	1.50	1.70	1.80
26	1.80	2.90	2.30	3.70	3.90	1.70	.75	.95	1.30	1.50	1.70	1.75
27	1.80	2.95	2.30	3.85	4.00	1.60	.65	.95	1.30	1.50	1.70	1.70
28	1.80	3.20	2.30	3.80	4.00	1.60	.65	.95	1.35	1.55	1.70	1.60
29	1.80	.....	2.30	3.80	4.10	1.55	.60	.95	1.35	1.55	1.75	1.60
30	1.75	.....	2.30	3.80	4.10	1.50	.60	.95	1.35	1.55	1.75	1.60
31	1.80	.....	2.25	.....	3.95	.....	.50	.95	.....	1.60	.....	1.60

OGDEN RIVER AT OGDEN, UTAH.

The following record of daily discharge of Ogden River was furnished through the courtesy of the Utah Light and Power Company, which maintains a dam on the river for power purposes, and measures the flow by means of a venturi meter. Gage readings are taken also at the dam.

Daily discharge in second-feet of Ogden River at Ogden, Utah, for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	53	.....	413	180	1,139	237	75	66	44	46	64	62
2	67	64	334	167	1,228	225	68	60	51	45	67	74
3	60	58	270	181	1,139	222	67	60	50	44	56	68
4	58	59	270	183	1,253	175	57	45	.....	43	65	68
5	54	61	259	168	1,160	185	66	56	40	58	66	69
6	77	67	276	169	1,062	184	69	59	47	43	66	77
7	80	66	238	172	1,098	177	64	56	45	48	63	77
8	54	67	267	197	1,139	164	69	69	42	47	55	71
9	77	67	204	160	1,226	164	71	59	44	45	61	80
10	74	56	218	169	1,327	145	78	61	50	47	51	77
11	74	68	193	191	1,372	144	68	53	46	45	60	64
12	67	62	187	186	1,302	135	65	62	46	49	62	43
13	50	57	188	194	1,301	127	69	62	47	42	63	.....
14	87	66	173	289	1,170	124	68	65	46	49	63	44
15	68	63	171	326	1,079	126	69	57	41	49	66	43
16	.....	63	.....	295	985	115	68	63	49	45	67	.....
17	62	55	.....	302	804	111	68	.....	52	46	49	.....
18	58	77	185	304	799	104	66	54	50	.....	66	35
19	58	67	167	384	726	107	60	69	35	45	67	44
20	68	83	176	421	660	105	61	69	46	40	63	57
21	71	205	179	584	596	104	60	69	48	52	55	49
22	72	216	187	650	519	80	60	67	37	48	60	34
23	98	188	206	.....	442	57	63	63	45	46	58	41
24	76	140	207	890	380	69	52	62	46	43	55	51
25	77	213	200	980	323	52	53	51	52	49	64	62
26	77	275	204	1,003	303	52	61	60	53	52	68	47
27	.....	536	191	848	287	82	68	53	50	38	70	46
28	.....	425	198	755	.....	91	57	54	91	68	55	52
29	77	.....	186	839	.....	99	75	61	47	84	66	39
30	65	.....	184	1,076	.....	96	69	57	49	65	64	52
31	69	.....	165	.....	.....	.....	62	60	.....	54	.....	47
Mean	69	127	217	423	919	129	65	60	48	49	62	56

WEBER RIVER NEAR UINTA, UTAH.

This station, established in October, 1899, is in the canyon, 5 miles east of Uinta, on the Union Pacific Railroad, immediately above the narrows known as Devils Gate. It is described in Water-Supply Paper No. 51, page 414. Measurements on this stream have been brought into considerable prominence during the past year on account of the effort to settle the complicated question of water rights among the fifty or sixty canals diverting its waters. Results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 411. The following measurements were made by G. L. Swendsen during 1901:

List of discharge measurements of Weber River near Uinta, Utah.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1901.	*Feet.*	*Sec.-ft.*	1901.	*Feet.*	*Sec.-ft.*
January 28	1.55	322	July 25	1.20	141
February 22	2.80	1,082	September 13	1.41	172
March 18	2.20	668	November 18	1.35	143
June 28	1.70	350			

Daily gage height, in feet, of Weber River near Uinta, Utah, for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.
1	1.50	1.50	3.90	1.90	4.25	3.00	1.70	1.20	1.40	1.50
2	1.50	1.50	3.90	1.90	4.40	3.00	1.60	1.20	1.40	1.50
3	1.50	1.50	3.35	1.90	4.65	2.95	1.60	1.20	1.40	1.50
4	1.50	1.50	2.90	2.05	4.70	2.75	1.60	1.20	1.40	1.50
5	1.50	1.50	2.35	1.95	4.70	2.60	1.50	1.20	1.40	1.50
6	1.50	1.50	2.35	1.90	4.50	2.55	1.50	1.20	1.40	1.50
7	1.50	1.50	2.40	1.90	4.10	2.50	1.50	1.20	1.40	1.50
8	1.50	1.50	2.35	1.90	3.90	2.50	1.50	1.60	1.40	1.50
9	1.50	1.50	2.05	2.00	3.95	2.45	1.50	1.60	1.40	1.50
10	1.50	1.50	2.00	2.10	4.20	2.40	1.50	1.50	1.40	1.50
11	1.50	1.50	2.05	2.10	4.25	2.40	1.40	1.50	1.40	1.50
12	1.50	1.50	2.05	2.20	4.25	2.40	1.40	1.50	1.40	1.50
13	1.50	1.50	1.95	2.20	4.50	2.30	1.40	1.40	1.40	1.50
14	1.50	1.50	1.90	2.20	4.50	2.10	1.40	1.40	1.40	1.50
15	1.50	1.50	1.90	2.30	4.50	2.05	1.40	1.40	1.40	1.50
16	1.50	1.85	1.90	2.40	4.50	2.00	1.40	1.40	1.40	1.50
17	1.50	2.15	2.05	2.45	4.50	2.00	1.40	1.40	1.40	1.50
18	1.50	2.30	2.10	2.50	4.50	2.00	1.40	1.40	1.40	1.50
19	1.50	2.80	2.10	2.60	4.50	2.00	1.40	1.40	1.40	1.50
20	1.50	2.85	2.00	2.60	4.35	2.00	1.30	1.40	1.40	1.50
21	1.50	3.50	2.00	2.65	4.10	2.00	1.30	1.40	1.40	1.50
22	1.50	2.80	1.90	2.90	4.00	2.00	1.30	1.40	1.40	1.50
23	1.50	2.60	2.00	3.20	3.85	1.90	1.30	1.40	1.40	1.50
24	1.50	2.80	1.90	3.35	3.65	1.90	1.30	1.10	1.40	1.50
25	1.50	3.35	1.90	3.40	3.60	1.90	1.30	1.60	1.40	1.50
26	1.50	3.50	1.90	3.40	3.45	1.90	1.20	1.60	1.40	1.50
27	1.50	3.50	1.90	3.60	3.35	1.90	1.20	1.60	1.40	1.60
28	1.50	3.60	1.90	3.75	3.20	1.80	1.20	1.60	1.40	1.60
29	1.50	.....	1.90	3.85	3.05	1.80	1.20	1.60	1.40	1.60
30	1.50	.....	1.90	4.05	3.00	1.80	1.20	1.50	1.40	1.60
31	1.50	.....	1.90	.....	3.00	.....	1.20	1.50	.....	1.60

SPANISH FORK NEAR MAPLETON, UTAH.

This station, established by C. C. Babb on May 23, 1900, is in the canyon of the river 3 miles above the Rio Grande Western Railway station at Mapleton, and a short distance above the head of the upper

canal diverting water from the river. It is described in Water-Supply Paper No. 51, page 415. The station was discontinued November 1, 1901. The stream furnishes water for the irrigation of some of the best lands of Utah County, and during the past season of general low water has proved an exception to the general rule, maintaining a fairly uniform discharge during the entire summer. This condition is probably due to the fact that the drainage area is not a public range. A measurement was made by G. L. Swendsen August 12, 1901, the discharge of that date being 95 second-feet and the gage height 2.09 feet.

Daily gage height, in feet, of Spanish Fork near Mapleton, Utah, for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	[a]2.25	1.80	2.20	2.10	2.60	2.50	2.05	2.00	2.00	2.00	2.05
2	[a]2.55	1.75	2.25	2.10	2.65	2.45	2.05	2.00	2.00	2.00	2.05
3	1.70	1.80	2.30	2.10	2.65	2.40	2.05	2.10	2.00	2.00	2.05
4	1.70	1.80	2.20	2.10	2.65	2.45	2.05	2.05	2.00	2.00	2.05
5	1.70	1.85	2.20	2.05	2.55	2.40	2.05	2.00	2.00	2.00	2.05
6	1.75	1.80	2.10	2.10	2.55	2.40	2.05	2.30	2.00	2.10	2.05
7	1.85	1.85	2.10	2.10	2.60	2.40	2.00	2.40	2.00	2.05	2.05
8	1.80	1.80	2.20	2.10	2.60	2.30	2.00	2.30	2.00	2.05	2.05
9	1.70	1.70	2.10	2.10	2.65	2.30	2.00	2.30	2.00	2.10	2.05
10	1.65	1.75	1.95	2.10	2.85	2.30	2.00	2.30	2.00	2.05	2.05
11	[a]1.90	1.65	2.10	2.10	2.95	2.30	2.05	2.10	2.00	2.05	2.10
12	1.80	1.75	2.10	2.15	3.00	2.30	2.05	2.05	2.00	2.05	2.05
13	1.75	1.85	2.00	2.18	3.15	2.30	2.00	2.05	2.00	2.05	2.05
14	1.75	1.80	2.05	2.20	3.20	2.30	2.00	2.00	2.00	2.00	2.05
15	1.80	1.80	2.10	2.20	3.15	2.30	2.00	1.95	2.00	2.00	2.00
16	1.80	1.85	2.10	2.15	3.30	2.30	2.00	2.15	2.00	2.00	2.00
17	1.85	2.01	2.15	2.10	3.30	2.25	2.00	2.00	2.00	2.00	2.00
18	1.75	2.45	2.10	2.15	3.25	2.25	1.95	2.00	2.00	2.00	2.00
19	1.80	2.35	2.15	2.20	3.20	2.25	1.95	2.20	2.00	2.00	2.00
20	1.70	3.23	2.00	2.25	3.20	2.20	1.95	2.20	2.00	2.00	2.00
21	1.80	2.80	2.10	2.40	3.15	2.20	1.95	2.15	2.00	2.00	2.00
22	1.80	2.75	2.10	2.40	3.05	2.20	1.95	2.00	2.00	2.00	2.00
23	1.85	2.23	2.10	2.35	2.90	2.10	2.00	2.10	2.00	2.00	2.00
24	1.80	2.25	2.10	2.43	2.85	2.05	2.00	2.10	2.05	2.00	2.05
25	1.80	2.15	2.00	2.55	2.70	2.05	2.00	2.10	2.00	2.00	2.05
26	1.85	2.25	2.10	2.60	2.65	2.10	2.05	2.05	2.00	2.00	2.05
27	1.70	2.15	2.00	2.50	2.65	2.10	2.05	2.05	2.00	2.10	2.00
28	1.80	2.30	2.10	2.65	2.60	2.10	2.00	2.05	2.00	2.20	2.00
29	1.80	.....	2.10	2.45	2.50	2.10	2.00	2.25	2.00	2.10	2.00
30	1.80	.....	2.00	2.55	2.45	2.05	2.00	2.05	2.00	2.05	2.10
31	1.80	.....	2.00	.....	2.50	.....	2.05	2.00	.....	2.05	.....

[a] Ice at gage.

PROVO RIVER NEAR PROVO, UTAH.

This station, established July 27, 1889, is in the canyon about 6 miles from Provo, and above the head of most of the irrigation canals of Utah Valley. The station is described in Water-Supply Paper No. 51, page 416. The results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 416. During 1901 the following measurements were made by G. L. Swendsen:

April 6: Gage height, 4.70 feet; discharge, 353 second-feet.
June 29: Gage height, 4.10 feet; discharge, 285 second-feet.
August 13: Gage height, 4.10 feet; discharge, 211 second-feet.
July 22: Gage height, 4.20 feet; discharge, 223 second-feet.
November 11: Gage height, 4.10 feet; discharge, 224 second-feet.

Daily gage height, in feet, of Provo River at Provo, Utah, for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	4.50	4.50	4.90	4.50	5.40	5.70	4.20	4.10	4.20	4.20	4.40
2	4.50	4.50	4.90	4.50	5.30	5.50	4.20	4.10	4.20	4.20	4.40
3	4.50	4.50	4.80	4.50	5.30	5.40	4.20	4.10	4.20	4.20	4.40
4	4.50	4.50	4.80	4.50	5.30	5.30	4.20	4.20	4.20	4.20	4.40
5	4.50	4.50	4.80	4.50	5.30	5.20	4.20	4.20	4.20	4.20	4.40
6	4.50	4.50	4.80	4.50	5.40	5.10	4.20	4.20	4.20	4.20	4.40
7	4.50	4.50	4.70	4.50	5.40	5.10	4.20	4.20	4.20	4.20	4.40
8	4.50	4.50	4.70	4.50	5.30	5.10	4.20	4.20	4.20	4.20	4.40
9	4.50	4.50	4.60	4.50	5.30	5.10	4.20	4.20	4.20	4.20	4.40
10	4.50	4.50	4.60	4.50	5.30	5.10	4.20	4.20	4.20	4.20	4.40
11	4.60	4.40	4.60	4.50	5.60	5.00	4.20	4.20	4.20	4.20	4.40
12	4.60	4.30	4.50	4.50	5.90	4.90	4.20	4.20	4.20	4.20	4.40
13	4.60	4.30	4.50	4.50	6.20	4.80	4.20	4.20	4.20	4.30	4.40
14	4.60	4.30	4.50	4.60	6.40	4.70	4.20	4.20	4.20	4.30	4.40
15	4.50	4.50	4.60	4.70	6.40	4.70	4.20	4.20	4.20	4.30	4.40
16	4.50	4.80	4.60	4.70	6.50	4.60	4.20	4.20	4.20	4.30	4.40
17	4.40	5.00	4.60	4.60	6.60	4.60	4.20	4.20	4.20	4.30	.....
18	4.40	6.00	4.60	4.60	6.60	4.50	4.20	4.20	4.20	4.30	.....
19	4.40	6.60	4.60	4.70	7.10	4.50	4.20	4.20	4.20	4.30	.....
20	4.50	6.60	4.60	4.70	7.00	4.50	4.20	4.20	4.20	4.30	.....
21	4.50	5.50	4.60	4.90	6.80	4.50	4.20	4.20	4.20	4.30	.....
22	4.60	4.90	4.60	5.00	6.50	4.50	4.20	4.20	4.20	4.30	.....
23	4.60	4.90	4.60	5.00	6.00	4.50	4.20	4.20	4.20	4.30	.....
24	4.70	4.90	4.60	5.10	6.00	4.40	4.20	4.20	4.20	4.30	.....
25	4.70	4.90	4.50	5.10	6.10	4.40	4.20	4.20	4.20	4.30	.....
26	4.70	4.90	4.50	5.10	6.30	4.30	4.20	4.20	4.20	4.30	.....
27	4.70	4.80	4.50	5.20	6.50	4.20	4.20	4.20	4.20	4.50	.....
28	4.70	4.80	4.50	5.60	6.50	4.20	4.20	4.20	4.20	4.50	.....
29	4.60	.....	4.50	5.50	6.40	4.10	4.20	4.20	4.20	4.50	.....
30	4.60	.....	4.50	5.40	6.30	4.20	4.10	4.20	4.20	4.40	.....
31	4.50	.....	4.50	.....	6.00	4.20	4.10	4.20	.....	4.40	.....

AMERICAN FORK NEAR AMERICAN FORK, UTAH.

This station, established by C. C. Babb on May 21, 1900, is 6 miles northeast of the town of American Fork. It is described in Water-Supply Paper No. 51, page 417. The station was abandoned June 15, 1901, when the observer left the place. A measurement was made by G. L. Swendsen on April 7, 1901, when the discharge was 31 second-feet and the gage height 0.35 foot.

Daily gage height, in feet, of American Fork near American Fork, Utah, for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	Day.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	0.34	0.33	0.37	.....	1.16	.....	17	0.33	0.36	0.35	0.42	1.74	.....
2	.34	.33	.37	.....	1.10	.....	18	.33	.34	.37	.45	1.77	.....
3	.34	.32	.36	.....	1.00	.....	19	.33	.43	.37	.49	.....	.....
4	.34	.32	.36	.....	.95	.....	20	.33	.39	.38	.61	.....	.....
5	.34	.32	.36	.....	.99	.....	21	.33	.39	.39	.68	.....	.....
6	.34	.32	.36	.....	1.07	.....	22	.33	.38	.39	.70	.....	.....
7	.34	.32	.36	.....	1.23	.....	23	.33	.38	.39	.72	.....	.....
8	.33	.32	.36	.....	1.37	.....	24	.33	.37	.37	.82	.....	.....
9	.33	.32	.36	.....	1.48	1.10	25	.33	.36	.34	.95	.....	.....
10	.33	.32	.36	0.35	1.63	1.05	26	.33	.36	.36	.91	.....	.....
11	.33	.32	.36	.36	1.65	1.00	27	.33	.36	.37	.82	.....	.....
12	.33	.32	.36	.38	1.65	.96	28	.33	.36	.37	.83	.....	.....
13	.34	.32	.36	.42	1.47	.92	29	.33	.....	.39	.87	.....	.....
14	.34	.32	.36	.48	1.59	.88	30	.33	.....	.....	1.00	.....	.....
15	.33	.32	.35	.47	1.67	.87	31	.33	.....	.....	.....	.....	.....
16	.33	.32	.35	.44	1.69	.....							

NOTE.—No record from March 30 to April 10.

SALINA CREEK NEAR SALINA, UTAH.

This station, established by Caleb Tanner on July 2, 1900, is in the canyon of the creek, about 5 miles southeast of Salina. It is described

in Water-Supply Paper No. 51, page 423. Results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 417. The gage was washed out on May 4, 1901, and has not been reestablished.

Daily gage height, in feet, of Salina Creek near Salina, Utah, for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	Day.	Jan.	Feb.	Mar.	Apr.	May.
1	1.20	1.15	1.20	1.12	1.40	17	1.12	1.25	1.10	1.25	...
2	1.20	1.15	1.20	1.12	1.42	18	1.12	1.25	1.10	1.25	...
3	1.20	1.18	1.18	1.15	1.45	19	1.12	1.25	1.10	1.27	...
4	1.20	1.18	1.18	1.15	1.30	20	1.15	1.25	1.10	1.27	...
5	1.20	1.18	1.15	1.15	.....	21	1.15	1.22	1.10	1.30	...
6	1.28	1.18	1.15	1.18	.....	22	1.15	1.20	1.10	1.30	...
7	1.28	1.18	1.10	1.15	.....	23	1.15	1.20	1.10	1.30	...
8	1.28	1.18	1.10	1.15	.....	24	1.15	1.20	1.10	1.32	...
9	1.28	1.18	1.10	1.15	.....	25	1.15	1.20	1.10	1.32	...
10	1.28	1.12	1.10	1.15	.....	26	1.15	1.20	1.10	1.32	...
11	1.28	1.12	1.10	1.15	.....	27	1.15	1.20	1.10	1.35	...
12	1.28	1.12	1.10	1.15	.....	28	1.15	1.20	1.10	1.35	...
13	1.12	1.12	1.10	1.20	.....	29	1.15	.....	1.10	1.37	...
14	1.12	1.12	1.10	1.22	.....	30	1.15	.....	1.10	1.37	...
15	1.12	1.12	1.10	1.22	.....	31	1.15	.....	1.10	.....	...
16	1.12	1.12	1.10	1.25	.....						

SAN PITCH RIVER NEAR GUNNISON, UTAH.

This station, established by Caleb Tanner on June 30, 1900, is 4 miles northeast of the town of Gunnison, at the ranch of the observer, J. P. Jensen. It is described in Water-Supply Paper No. 51, page 425. Results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 419. A measurement was made by C. Tanner July 19, 1901, which gave a discharge of 18 second-feet for a gage height of 1.82 feet.

Daily gage height, in feet, of San Pitch River near Gunnison, Utah, for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.70	1.70	1.86	(a)	2.50	2.40	2.20	1.82	1.80	1.78	1.78	1.74
2	1.70	1.70	1.80	(a)	2.36	2.40	2.24	1.90	1.80	1.78	1.78	1.74
3	1.70	1.74	1.76	(a)	2.30	2.40	2.20	1.82	1.80	1.78	1.78	1.74
4	1.78	1.74	1.76	(a)	2.20	2.40	2.18	1.84	1.76	1.78	1.78	1.74
5	1.78	1.70	1.78	(a)	2.20	2.30	2.20	1.82	1.76	1.78	1.78	1.74
6	1.80	1.76	1.74	(a)	2.10	2.30	2.20	1.80	1.70	1.78	1.78	1.74
7	1.82	1.70	1.76	1.70	2.10	2.30	2.20	1.82	1.70	1.78	1.78	1.74
8	1.78	1.80	1.74	1.70	2.30	2.30	2.22	1.90	1.70	1.78	1.78	1.74
9	1.76	1.80	1.80	1.70	2.30	2.30	2.20	1.84	1.70	1.78	1.78	1.74
10	1.70	1.70	1.76	1.68	2.40	2.30	2.18	1.82	1.70	1.78	1.78	1.74
11	1.74	1.70	1.84	1.70	2.40	2.26	2.20	1.80	1.78	1.78	1.78	1.74
12	1.76	1.68	1.80	1.76	2.50	2.26	2.18	1.80	1.78	1.78	1.78	1.74
13	1.74	1.70	1.82	1.80	2.50	2.30	2.20	1.80	1.80	1.78	1.78	1.74
14	1.70	1.79	1.82	1.76	2.30	2.30	2.20	1.80	1.80	1.78	1.78	1.74
15	1.70	1.78	1.80	1.80	2.30	2.30	2.20	1.80	1.80	1.78	1.78	1.74
16	1.70	1.80	1.80	1.78	2.40	2.30	2.18	1.82	1.80	1.78	1.78	1.74
17	1.68	1.80	1.78	1.80	2.50	2.30	2.18	1.82	1.78	1.78	1.70	1.74
18	1.70	1.78	1.70	1.80	2.40	2.26	2.12	1.90	1.78	1.78	1.70	1.74
19	1.70	1.84	1.70	1.76	2.50	2.26	2.00	1.86	1.78	1.78	1.70	1.74
20	1.70	1.84	1.74	1.76	2.60	2.20	1.90	1.80	1.80	1.80	1.70	1.74
21	1.76	1.86	1.74	1.90	2.40	2.30	1.82	1.80	1.80	1.78	1.70	1.74
22	1.80	1.80	1.70	1.90	2.40	2.30	1.82	1.80	1.80	1.78	1.70	1.74
23	1.80	1.80	1.70	2.20	2.30	2.30	1.80	1.80	1.78	1.78	1.70	1.74
24	1.76	1.98	1.74	2.30	2.30	2.20	1.80	1.80	1.78	1.78	1.70	1.76
25	1.76	2.00	1.70	2.36	2.20	2.20	1.82	1.80	1.80	1.78	1.74	1.76
26	1.70	1.90	1.70	2.30	2.40	2.20	1.80	1.80	1.80	1.78	1.74	1.76
27	1.74	1.90	1.68	2.28	2.40	2.20	1.82	1.80	1.80	1.84	1.74	1.76
28	1.74	1.88	1.70	2.24	2.60	2.20	1.82	1.80	1.80	1.80	1.74	1.76
29	1.70	.....	1.80	2.30	2.60	2.20	1.80	1.80	1.80	1.80	1.74	1.74
30	1.74	.....	1.80	2.30	2.50	2.20	1.80	2.10	1.80	1.78	1.74	1.74
31	1.70	.....	(a)	.....	2.50	.....	1.80	1.90	.....	1.78	.....	1.74

a No record.

SEVIER RIVER NEAR GUNNISON, UTAH.

This station, established by Caleb Tanner on June 29, 1900, is at the bridge which crosses the stream 4 miles west of the town of Gunnison. It is described in Water-Supply Paper No. 51, page 425. During the last two years this stream has been the source of a great amount of litigation in relation to water rights, and there has been great need of information relative to the volume of water at different points. Results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 420. A measurement was made by C. Tanner on July 20, when the discharge was 10 second-feet and the gage height 0.45 foot.

Daily gage height, in feet, of Sevier River near Gunnison, Utah, for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	(a)	1.65	1.32	1.25	1.15	1.80	0.40	0.67	0.60	0.45	0.60	0.90
2	(a)	1.67	1.30	1.15	1.15	1.65	.37	.80	.60	.45	.60	.90
3	(a)	1.65	1.28	1.12	1.22	1.60	.37	.80	.55	.42	.62	.90
4	(a)	1.67	1.22	1.12	1.02	1.55	.35	.82	.60	.42	.62	.90
5	(a)	1.77	1.18	1.10	1.10	1.40	.37	.80	.60	.42	.65	.90
6	1.30	1.67	1.18	1.00	1.07	1.00	.37	.82	.55	.42	.70	.90
7	1.40	1.77	1.15	.92	1.10	1.00	.37	.62	.50	.42	.72	.97
8	1.35	1.67	1.10	.92	1.05	1.00	.37	.60	.60	.42	.85	1.00
9	1.35	1.67	1.10	1.00	1.15	.90	.37	.60	.60	.42	.85	1.00
10	1.30	1.63	1.10	1.00	1.15	.60	.37	.57	.57	.42	.85	1.05
11	1.45	1.70	1.10	.62	1.25	.60	.37	.57	.57	.42	.85	1.05
12	1.55	1.67	1.10	1.00	1.40	.55	.37	.55	.55	.42	.85	1.05
13	1.75	1.65	1.02	.92	1.25	.50	.37	.55	.55	.42	.82	1.05
14	1.73	1.55	1.02	.92	1.40	.50	.37	.55	.55	.42	.82	1.05
15	1.73	1.78	1.02	1.00	1.60	.95	.47	.55	.55	.42	.82	1.15
16	1.80	1.78	1.02	.82	1.65	.95	.47	.60	.52	.42	.85	1.15
17	1.58	1.95	1.02	.87	1.90	.95	.47	.95	.50	.42	.85	1.15
18	1.67	1.95	1.02	.87	2.00	.90	.47	.87	.50	.42	.85	1.45
19	1.80	2.05	1.02	.87	2.30	.90	.47	.80	.50	.42	.90	1.50
20	1.70	2.15	1.00	.90	2.60	.92	.47	1.10	.50	.42	.95	1.50
21	1.87	2.15	.90	.87	2.80	.90	.45	.97	.45	.42	.90	1.60
22	1.95	2.00	.90	.87	2.90	.90	.45	.72	.45	.42	.90	1.70
23	1.75	1.93	.75	.90	2.50	.60	.45	.60	.45	.42	.90	1.70
24	1.92	1.93	.75	.87	2.50	.50	.47	.60	.45	.42	.90	1.75
25	1.87	1.70	.75	.90	2.20	.50	.57	.60	.45	.42	.90	1.80
26	1.93	1.62	1.02	.95	2.10	.50	.57	.55	.45	.42	.90	1.90
27	1.90	1.50	1.12	.95	2.10	.47	.60	.55	.45	.42	.90	2.00
28	1.87	1.45	1.22	.92	2.05	.45	.60	.60	.45	.47	.90	2.00
29	1.85	.....	1.12	.92	2.05	.47	.60	.60	.45	.50	.90	1.90
30	1.80	.....	1.12	.95	2.00	.47	.65	.55	.45	.52	.90	2.05
31	1.65	.....	1.15	.....	1.85	.....	.65	.60	.....	.52	.....	2.00

(a) Ice.

COLUMBIA RIVER DRAINAGE.

SNAKE RIVER AT MONTGOMERY FERRY, IDAHO.

This station, established October 5, 1895, is on the stage road from Minidoka to Albion. It is described in Water-Supply Paper No. 51, page 426.

The station was reestablished May 1, 1901, and the gage read morning and evening for the remainder of the year. Part of the inclined gage rod which had been moved by quicksand was corrected August 9, 1901, and all previous gage readings were carefully adjusted to correspond with the present position of the rod. The following measurements were made by N. S. Dils during 1901:

July 6: Gage height, 2.90 feet; discharge, 6,753 second-feet.

August 11: Gage height, 0.90 foot; discharge, 2,090 second-feet.

Daily gage height, in feet, of Snake River at Montgomery Ferry, Idaho, for 1901.

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.85	7.75	3.30	0.90	1.00	1.90	2.30	2.50
2	3.85	7.80	3.15	.90	1.00	1.90	2.40	2.50
3	4.28	7.60	3.20	.90	1.00	2.00	2.40	2.60
4	5.70	7.55	3.08	.90	1.10	2.00	2.40	2.70
5	5.70	7.10	2.98	.90	1.10	2.00	2.30	2.70
6	6.25	6.90	2.90	.90	1.10	2.00	2.40	2.70
7	6.53	6.68	2.65	.90	1.20	2.00	2.40	2.70
8	6.53	6.55	2.65	.90	1.20	2.00	2.40	2.70
9	6.48	6.45	2.60	.90	1.20	2.00	2.40	2.70
10	6.40	6.10	2.40	.90	1.20	2.10	2.40	2.70
11	6.50	5.85	2.45	.90	1.20	2.10	2.50	2.70
12	6.73	5.58	2.35	.90	1.30	2.10	2.50	2.70
13	6.75	5.35	2.25	.90	1.30	2.10	2.50	2.70
14	6.95	5.15	2.20	.90	1.30	2.10	2.50	2.70
15	7.10	4.63	2.08	.90	1.30	2.10	2.50	3.70
16	7.55	4.40	2.00	.90	1.35	2.10	2.50	4.40
17	7.20	4.23	2.00	.90	1.40	2.20	2.50	4.35
18	7.25	4.00	2.00	.90	1.40	2.20	2.50	4.15
19	7.10	3.85	1.90	.90	1.40	2.20	2.50	4.10
20	7.00	3.70	1.80	.90	1.50	2.20	2.50	3.85
21	7.80	3.65	1.70	.90	1.50	2.20	2.50	3.50
22	8.35	3.65	1.60	.90	1.60	2.20	2.50	3.70
23	8.15	3.60	1.55	.90	1.60	2.20	2.50	3.50
24	8.15	3.75	1.45	.90	1.60	2.20	2.50	2.60
25	7.85	3.85	1.35	1.00	1.70	2.20	2.50	2.60
26	8.00	3.85	1.15	1.00	1.70	2.20	2.50	2.50
27	7.50	3.75	1.03	1.00	1.75	2.20	2.50	2.70
28	7.10	3.60	.93	1.00	1.80	2.20	2.50	3.80
29	7.25	3.50	.90	1.00	1.80	2.20	2.50	3.80
30	7.45	3.40	.90	1.00	1.90	2.30	2.50	4.40
31	7.65	.....	.90	1.00	.....	2.30	.....	4.30

BRUNEAU RIVER NEAR GRANDVIEW, IDAHO.

This station, established by Mr. A. J. Wiley for the Owyhee Land and Irrigation Company, is immediately below the headworks of the canal system of that company, 10 miles east of Grandview. Records have been maintained ever since 1896. It is described in Water-Supply Paper No. 51, page 426. No measurements were made at this station during 1901.

Daily gage height, in feet, of Bruneau River near Grandview, Idaho, for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.45	.....	2.80	1.80	2.75	2.95	1.85	1.20	1.00	1.35	1.60	1.60
2	1.45	.....	3.00	1.80	2.90	2.90	1.85	1.20	1.00	1.35	1.60	1.65
3	1.45	1.50	3.10	1.80	3.00	2.85	1.80	1.20	1.00	1.35	1.60	1.70
4	1.50	1.50	2.80	1.90	2.95	2.70	1.75	1.20	1.00	1.60	1.60	1.80
5	1.55	1.50	2.50	1.90	2.85	2.70	1.70	1.20	1.00	1.50	1.60	1.70
6	1.60	1.60	2.35	1.83	2.80	2.65	1.65	1.20	1.00	1.50	1.60	1.70
7	1.65	1.60	2.25	1.85	2.80	2.55	1.60	1.15	1.00	1.50	1.60	1.70
8	1.60	1.60	2.25	1.85	2.85	2.50	1.58	1.15	1.00	1.50	1.60	1.70
9	1.55	1.60	2.25	1.80	3.00	2.50	1.50	1.15	1.05	1.50	1.60	1.70
10	1.55	1.55	2.20	1.80	3.00	2.45	1.50	1.10	1.10	1.50	1.60	1.70
11	1.55	1.50	2.10	1.80	3.20	2.40	1.45	1.10	1.15	1.55	1.60	1.70
12	1.55	1.50	2.00	1.80	3.30	2.30	1.45	1.10	1.15	1.55	1.55	1.65
13	1.65	1.55	2.00	1.80	3.45	2.25	1.40	1.10	1.15	1.50	1.55	1.60
14	1.65	1.55	1.90	2.30	3.70	2.20	1.40	1.10	1.15	1.55	1.55	1.55
15	1.60	1.60	1.90	2.75	3.70	2.15	1.40	1.10	1.15	1.55	1.55	1.55
16	1.55	1.60	1.90	2.80	3.65	2.10	1.40	1.10	1.20	1.55	1.55	1.55
17	1.55	3.10	1.90	2.70	3.65	2.05	1.35	1.10	1.20	1.50	1.55	1.55
18	1.55	3.85	1.95	2.60	3.75	2.00	1.35	1.10	1.20	1.50	1.55	1.55
19	1.50	3.00	2.00	2.55	3.75	2.00	1.30	1.10	1.20	1.50	1.55	1.60
20	1.50	2.35	2.00	2.50	3.70	2.00	1.30	1.05	1.20	1.50	1.55	1.60
21	1.55	4.90	1.90	2.70	3.40	2.10	1.25	1.00	1.20	1.50	1.55	1.60
22	1.60	4.65	1.90	2.75	3.23	2.05	1.25	1.00	1.25	1.50	1.55	1.60
23	1.65	3.60	1.95	2.80	3.10	2.00	1.25	1.00	1.25	1.55	1.60	1.60
24	1.60	2.70	2.00	2.88	3.00	2.00	1.25	1.00	1.30	1.50	1.60	1.60
25	1.55	2.65	2.00	2.90	2.85	2.00	1.20	1.00	1.30	1.50	1.60	1.65
26	1.60	2.60	1.95	2.90	2.80	1.95	1.20	1.00	1.35	1.50	1.60	1.65
27	1.55	2.40	1.95	2.90	3.20	1.95	1.20	1.00	1.35	1.55	1.60	1.65
28	1.55	2.30	1.90	2.80	3.30	1.90	1.20	1.00	1.35	1.55	1.60	1.65
29	1.55	.....	1.85	2.80	3.10	1.90	1.20	1.00	1.35	1.55	1.60	1.65
30	1.55	.....	1.85	2.75	3.00	1.88	1.20	1.00	1.35	1.55	1.60	1.65
31	1.60	.....	1.80	.....	3.00	.....	1.20	1.00	.....	1.55	.....	1.65

BOISE RIVER NEAR BOISE, IDAHO.

This station is described in Water-Supply Paper No. 51, page 427. Results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 431.

During the fall of 1901 the deadmen used in anchoring the cable were renewed and the following discharge measurements were made by N. S. Dils, who also made a number of measurements of Boise River and other streams of Boise Valley for the purpose of ascertaining the seepage into Boise River, the results of which are here given:

List of discharge measurements of Boise River near Boise, Idaho.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1901.	*Feet.*	*Sec.-ft.*	1901.	*Feet.*	*Sec.-ft.*
March 27	2.65	2,463	August 15	0.63	779
April 26	5.15	8,527	August 24	.60	856
June 4	4.70	7,053	Do[a]		905
June 24	3.70	5,117	September 27	.90	1,015
July 11	2.20	2,141	August 3	1.00	1,128
July 22	1.55	1,468			

[a] Four miles above Boise station.

Daly gage height, in feet, of Boise River near Boise, Idaho, for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.20	1.25	3.30	2.20	5.50	5.00	2.80	1.00	0.55	0.70	0.80	1.10
2	1.20	1.10	3.60	2.35	6.10	5.00	2.80	1.00	.55	.70	.80	2.30
3	1.40	1.20	3.45	2.50	5.85	5.00	2.80	1.00	.55	.83	.80	2.20
4	1.35	1.25	3.30	2.45	6.10	4.70	2.75	.98	.65	.90	.75	2.20
5	1.42	1.10	2.90	2.40	6.50	4.40	2.50	.93	.65	.95	.80	2.00
6	1.60	1.25	2.80	2.40	6.20	4.10	2.40	.85	.60	1.03	.80	1.70
7	1.45	1.15	3.00	2.40	6.10	4.00	2.40	.70	.60	.90	.75	1.40
8	1.40	1.15	3.00	2.40	6.00	3.80	2.40	.53	.60	.95	.75	1.25
9	1.40	1.05	2.80	2.45	6.15	3.70	2.30	.53	.60	.80	.75	1.35
10	1.40	1.20	2.70	2.70	6.30	3.60	2.30	.53	.55	.75	.75	1.20
11	1.30	1.20	2.65	3.10	6.55	3.50	2.20	.60	.55	.75	.75	1.10
12	1.30	1.30	2.50	3.50	6.60	3.45	2.10	.65	.50	.75	.68	1.00
13	1.30	1.30	2.30	3.80	6.90	3.30	2.10	.63	.55	.75	.75	.80
14	1.40	1.25	2.30	4.10	7.00	3.20	2.00	.65	.55	.75	.68	.65
15	1.50	1.40	2.30	4.00	7.00	3.20	1.90	.60	.55	75	.75	1.00
16	1.30	2.50	2.30	3.80	7.20	3.30	1.90	.65	.60	.73	.75	.85
17	1.30	2.25	2.60	3.90	7.20	3.50	1.80	.63	.55	.70	.70	.90
18	1.20	2.00	2.60	4.00	7.10	3.60	1.75	.60	.60	.70	.70	.95
19	1.20	2.30	2.60	4.30	6.70	3.70	1.70	.60	.55	.70	70	.95
20	1.30	2.30	2.70	4.60	6.00	3.90	1.70	.63	.55	.70	.70	.80
21	1.35	2.15	2.80	4.60	5.80	4.00	1.63	.65	.65	.70	.70	.75
22	1.40	1.95	3.30	4.75	5.40	3.90	1.60	.65	.70	.73	.80	1.03
23	1.35	2.10	3.10	5.00	5.10	3.70	1.65	.60	.80	.70	.90	1.20
24	1.30	2.00	2.90	5.40	4.90	3.50	1.70	.60	.90	.70	1.20	1.50
25	1.25	2.20	2.90	5.05	5.00	3.20	1.65	.50	.90	.70	.98	1.40
26	1.20	2.10	2.65	5.15	5.30	2.90	1.60	.55	.88	.70	.90	1.20
27	1.20	3.40	2.60	4.80	5.40	2.80	1.40	.50	.88	70	1.00	1.10
28	1.20	3.50	2.50	4.70	5.60	2.70	1.20	.58	.75	.85	.90	1.10
29	1.10	.....	2.35	4.90	5.60	2.80	1.10	.55	.75	.90	.95	.85
30	1.10	.....	2.30	5.30	5.40	2.90	1.03	60	.70	.80	1.08	.75
31	1.20	.....	2.30	.....	5.20	.....	1.00	55	.....	80	.....	.95

Miscellaneous discharge measurements of Boise River and other streams in Boise Valley, Idaho, for the purpose of ascertaining the seepage into Boise River.

Date.	Stream.	Locality.	Discharge.
1901.			*Sec.-ft.*
Aug. 13	Sebree canal	Near head	11.7
Do	Seitenberg slough	do	2.5
Do	Boise River	At Caldwell road bridge	14.2
Do	Riverside canal	do	50.4
Do	2 wastes east of Caldwell	Near river	1.4
Do	Waste from Tenmile Creek	Lower road	1.3
Do	Strahorn canal	Below waste gate	16.2
Do	Waste near Star	Near river	1.0
Do	Boise River	At Star bridge	62.5
Aug. 14	2 wastes near Star	Near river	2.6
Do	Phyllis canal	Near head	14.1
Do	Eureka canal	do	2.1
Do	Settlers canal	¼ mile below head	95.4
Do	Davis canal	Near head	20.0
Do	McCarty canal	do	96.4
Do	Rossi waste	Near river	43.0
Do	Rossi canal	Below waste gate	61.6
Do	Paynne canal	Flume on Bound's ranch	9.5
Aug. 15	Ellis canal	Near head	34.6
Do	Perrault canal	Below waste gate	76.4
Do	Boise River	At gaging station	778.8
Do	New York canal	do	42.2
Do	Castin canal	Near head	6.9
Do	Lamberger & Ryan ditch	In flume (lift by wheel)	.7
Do	Ridenbaugh canal	Below scour gate	440.4
Do	Waste at Broadway bridge	Near river	2.0
Do	Jacobs canal	Below waste gate	51.1
Aug. 16	Waste from car line power house	Road bridge	36.2
Do	Waste from electric-light works		25.0
Do	Farmers' Union canal	Below waste gate	83.0
Do	Waste ½ mile below Soldiers' Home	Near river	8.0
Do	Waste from sand gulch	do	7.3
Do	Union canal	Near head	15.0
Do	Dry Creek canal	do	15.7
Do	Ballentine's canal	do	Dry.
Do	Conway & Akin, 2 ditches	Eagle Island	5.0
Do	Catlin & Macey, 2 ditches	do	4.8
Do	Davis & Hart ditch	do	8.5
Do	Middleton Mill Slough canal	Near head	9.1
Do	Middleton Canal Co. canal	do	2.0
Do	Pionies canal	do	26.9
Aug. 17	Middleton Water Co. canal	do	2.5
Do	Waste east of Middleton	Near river	3.6
Do	Waste from Willow Creek	do	1.0
Do	Sebree canal	Near head	17.9
Do	Seitenberg slough	do	1.0
Do	Boise River	At Caldwell bridge	1.2
Do	Riverside canal	Road bridge	46.8

WEISER RIVER NEAR WEISER, IDAHO.

This station, established December 6, 1894, is described in Water-Supply Paper No. 51, page 430. The results of measurements for 1900 are given in the Twenty-second Annual Report, Part IV, page 432. In the fall of 1901 new deadmen were set and the cable secured to them. The following discharge measurements were made by N. S. Dils during 1901:

April 19: Gage height, 4 feet; discharge, 2,727 second-feet.
June 8: Gage height, 2.40 feet; discharge, 959 second-feet.
August 19: Gage height, 0.25 foot; discharge, 48 second-feet.
October 18: Gage height, 0.60 foot; discharge, 179 second-feet.

Daily gage height, in feet, of Weiser River near Weiser, Idaho, for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.50	1.70	6.50	2.80	4.50	3.80	1.80	1.00	0.25	0.55	0.80	1.30
2	1.40	1.70	6.50	2.70	4.80	3.70	1.80	.90	.25	.55	.85	1.40
3	1.60	1.60	6.20	3.10	5.10	3.50	1.70	.80	.25	.55	.85	2.15
4	2.20	1.60	5.60	3.00	5.20	3.30	1.70	.70	.30	.55	.85	2.70
5	2.50	1.60	5.10	2.90	5.30	3.20	1.70	.60	.30	.55	.85	2.60
6	2.40	1.60	4.70	3.50	5.50	3.20	1.60	.50	.30	.55	.85	2.50
7	2.20	1.60	4.60	3.60	5.30	3.00	1.70	.50	.30	.60	.85	2.45
8	2.00	1.60	4.50	3.30	5.10	2.90	1.60	.40	.30	.60	.85	2.30
9	2.00	1.60	4.40	3.10	5.00	2.90	1.60	.40	.30	.60	.85	2.20
10	1.90	1.60	4.30	3.20	5.00	2.90	1.50	.30	.40	.60	.85	2.40
11	1.90	1.60	4.20	3.20	5.00	2.90	1.40	.30	.40	.60	.85	2.20
12	1.90	1.60	4.10	3.50	5.10	2.80	1.40	.30	.40	.60	.85	1.80
13	2.50	1.60	4.00	3.60	5.50	2.80	1.40	.25	.40	.60	.80	1.20
14	4.70	1.70	3.90	3.70	5.60	2.80	1.30	.25	.40	.60	.80	1.20
15	4.60	1.70	3.80	3.80	5.70	2.80	1.30	.25	.40	.65	.80	1.30
16	3.10	2.50	3.70	3.90	5.60	2.60	1.30	.25	.40	.65	.80	1.30
17	2.10	4.80	3.60	3.90	5.70	2.60	1.30	.25	.40	.65	.80	1.30
18	2.40	3.60	3.50	4.00	5.50	2.40	1.20	.25	.40	.65	.80	1.30
19	2.20	2.90	3.40	4.00	5.00	2.30	1.20	.25	.45	.70	.85	1.20
20	2.10	2.80	3.30	4.10	4.70	2.30	1.20	.25	.45	.70	.85	1.20
21	2.10	4.90	3.30	4.10	4.30	2.20	1.20	.25	.45	.70	.95	1.30
22	2.00	4.10	3.40	4.20	4.10	2.10	1.20	.25	.45	.70	1.15	1.30
23	2.00	3.80	3.60	4.30	3.90	2.10	1.10	.25	.50	.70	1.20	1.30
24	1.90	5.00	3.50	4.50	3.80	2.10	1.10	.20	.50	.70	1.30	1.30
25	1.90	4.80	3.40	4.50	4.00	2.10	1.10	.20	.50	.70	1.30	1.20
26	1.80	5.40	3.50	4.50	4.10	2.00	1.10	.20	.50	.70	1.30	1.20
27	1.80	7.25	3.40	4.40	4.20	2.00	1.10	.20	.50	.75	1.20	1.10
28	1.80	6.90	3.20	4.20	4.20	1.90	1.10	.20	.50	.75	1.10	1.10
29	1.70	.....	3.00	4.00	4.10	1.90	1.10	.20	.50	.80	1.15	1.10
30	1.70	.....	2.90	4.20	4.00	1.80	1.10	.20	.50	.80	1.15	1.10
31	1.70	.....	2.80	.....	3.90	.....	1.10	.20	.....	.80	.....	1.10

BLACKFOOT RIVER NEAR BONNER, MONT.

The station, established July 7, 1898, is at the wagon bridge one-half mile west of Bonner. It is described in Water-Supply Paper No. 51, page 430. Results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 433. The station was discontinued June 30, 1901. The following measurements of discharge were made during 1901 under the direction of Samuel Fortier:

March 23: Gage height, 1.18 feet; discharge, 1,058 second-feet.
April 25: Gage height, 2.08 feet; discharge, 1,833 second-feet.
April 25: Gage height, 2.10 feet; discharge, 1,875 second-feet.

Daily gage height, in feet, of Blackfoot River near Bonner, Mont., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	Day.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	0.50	0.60	2.65	0.70	3.45	4.90	17	.55	.40	.75	1.15	6.50	2.90
2	.60	.65	3.35	.65	4.20	4.70	18	.55	.45	.90	1.15	6.45	2.80
3	.70	.65	2.40	.55	5.10	4.50	19	.60	.45	.85	1.30	6.30	2.80
4	.85	.65	1.55	.55	5.45	4.30	20	.50	.30	.85	1.35	6.10	2.95
5	1.10	.55	1.05	.55	5.70	4.05	21	.50	.30	.95	1.50	5.70	3.00
6	.90	.50	1.00	.65	5.50	3.85	22	.50	.55	1.35	1.60	5.50	3.00
7	.90	.50	.85	.60	5.65	3.55	23	.60	.45	1.25	1.70	5.15	2.95
8	.85	.45	.90	.60	5.50	3.55	24	.75	.30	1.00	1.90	5.05	3.00
9	.70	.45	.90	.75	5.25	3.25	25	.65	.35	.90	2.10	4.95	2.80
10	.65	.45	.85	.70	5.25	3.25	26	.60	.45	.80	2.25	5.00	2.80
11	.70	.60	.85	.85	4.85	3.10	27	.55	.55	.80	2.35	5.15	2.80
12	.60	.55	.90	1.15	4.80	3.10	28	.55	1.45	.75	2.20	5.50	2.70
13	.65	.60	.75	1.45	5.10	3.10	29	.60	.....	.75	2.15	5.85	2.70
14	.90	.55	.60	1.35	5.35	3.00	30	.70	.....	.75	2.75	5.75	2.70
15	.85	.40	.55	1.05	5.35	2.90	31	.55	.....	.70	.....	5.30	.....
16	.75	.60	.65	1.20	5.75	2.90							

MISSOULA RIVER AT MISSOULA, MONT.

The station was originally established July 10, 1898, at the Higgins avenue bridge at Missoula, but owing to the unfavorable condition of the channel, was moved on May 27, 1899, to a point below the junction of the two branches and 150 yards east of the railroad bridge. It is described in Water-Supply Paper No. 51, page 432. Results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 435.

The gage wire was renewed April 10, 1901. The following measurements were made by G. C. Westby and J. S. Baker during 1901.

List of discharge measurements of Missoula River at Missoula, Mont.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1901.	*Feet.*	*Sec.-ft.*	1901.	*Feet.*	*Sec.-ft.*
March 27	3.80	1,804	November 30	3.39	1,309
April 27	5.29	4,222	Do	3.45	1,383
Do	5.30	4,295			

Daily gage height, in feet, of Missoula River at Missoula, Mont., for 1901.

Day.	Jan.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	(a)	.....	3.62	6.20	7.85	5.30	3.65	3.10	3.55	3.55	3.45
2	(a)	.....	3.63	6.98	7.55	5.25	3.65	3.10	3.55	3.55	3.50
3	(a)	5.62	3.62	7.58	7.38	5.10	3.65	3.15	3.53	3.55	3.53
4	(a)	4.63	3.55	8.28	7.33	5.10	3.65	3.28	3.55	3.53	3.58
5	(a)	4.00	3.53	8.45	7.28	5.00	3.65	3.50	3.55	3.58	3.53
6	(a)	3.95	3.55	8.25	6.95	4.85	2.63	3.53	3.50	3.65	3.50
7	(a)	3.90	3.55	8.05	6.60	4.83	3.58	3.50	3.50	3.63	3.43
8	(a)	4.00	3.55	7.95	6.38	4.82	3.55	3.53	3.50	3.60	3.30
9	(a)	4.02	3.55	7.95	6.25	4.73	3.55	3.53	3.50	3.60	3.43
10	(a)	3.93	3.60	7.75	6.08	4.77	3.50	3.50	3.58	3.58	3.58
11	(a)	3.87	.....	7.68	6.10	4.68	3.50	3.53	3.53	3.58	(a)
12	(a)	3.80	.....	7.55	6.15	4.55	3.43	3.58	3.50	3.55	(a)
13	(a)	3.80	4.40	7.75	6.18	4.47	3.40	4.50	3.50	3.55	(a)
14	(a)	3.75	4.30	8.05	6.08	4.45	3.38	3.53	3.50	3.53	(a)
15	(a)	3.73	4.00	8.33	5.95	4.43	3.33	3.55	3.50	3.50	(a)
16	(a)	3.78	4.08	8.45	5.85	4.38	3.33	3.50	3.53	3.45	(a)
17	(a)	3.80	4.02	8.80	5.78	4.33	3.30	3.50	5.55	3.45	(a)
18	(a)	3.98	4.12	9.00	5.67	4.25	3.30	3.50	3.53	3.50	(a)
19	(a)	3.95	4.10	8.90	5.65	4.13	3.30	3.53	3.50	3.50	(a)
20	.....	3.85	4.18	8.70	5.80	4.05	3.28	3.50	3.50	3.48	(a)
21	.....	3.90	4.32	8.40	5.90	4.00	3.25	3.45	3.50	3.48	(a)
22	.....	4.23	4.48	8.15	5.80	4.00	3.25	3.48	3.50	3.48	(a)
23	.....	4.17	4.67	8.10	5.75	3.98	3.25	3.48	3.55	3.53	(a)
24	.....	3.95	4.80	7.88	5.73	3.93	3.23	3.48	3.50	3.55	(a)
25	.....	3.87	4.97	7.70	5.67	3.88	3.25	3.50	3.48	3.53	(a)
26	.....	3.83	5.13	7.75	5.68	3.85	2.23	3.50	3.50	3.53	(a)
27	.....	3.78	5.20	7.85	5.73	3.85	3.15	3.58	3.58	3.50	(a)
28	.....	3.70	5.20	8.20	5.72	3.78	3.15	3.60	3.48	3.48	(a)
29	.....	3.70	5.20	8.45	5.55	3.75	3.15	3.60	3.53	3.45	(a)
30	.....	3.68	5.55	8.63	5.48	3.75	3.13	3.60	3.58	3.45	(a)
31	.....	3.60	.....	3.28	.....	3.70	3.10	.....	3.63	.....	(a)

[a] Ice.

BITTERROOT RIVER AT MISSOULA, MONT.

The station, established July 6, 1898, is at the Buckhouse wagon bridge. It is described in Water-Supply Paper No. 51, page 433. On April 8, 1901, the bridge was washed out and no readings were taken from April 8 to 12. The station was discontinued November 30, 1901. Results of measurements for 1900 are published in the Twenty-second

Annual Report, Part IV, page 442. The following measurements were made by G. C. Westby and J. S. Baker during 1901:

List of discharge measurements of Bitterroot River at Missoula, Mont.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1901.	*Feet.*	*Sec.-ft.*	1901.	*Feet.*	*Sec.-ft.*
March 23	1.80	1,484	December 1	1.27	1,223
April 25	2.85	2,660	Do	1.25	1,157
Do	2.85	2,670			

Daily gage height, in feet, of Bitterroot River at Missoula, Mont., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	(a)	1.10	3.00	1.65	5.30	6.80	3.60	1.30	0.50	1.15	1.15
2	(a)	1.05	2.70	1.65	5.50	6.00	3.55	1.30	.50	1.25	1.15
3	(a)	1.10	2.75	1.60	5.60	5.25	3.50	1.25	.55	1.30	1.25
4	(a)	1.10	2.60	1.60	5.70	5.70	3.45	1.15	.60	1.30	1.25
5	(a)	1.10	2.45	1.60	5.70	5.15	3.40	1.10	.70	1.30	1.25
6	(a)	(a)	2.25	1.60	5.65	5.00	3.30	1.00	.75	1.25	1.25
7	(a)	(a)	2.20	1.60	5.50	4.80	3.30	.95	.80	1.30	1.20
8	1.60	(a)	2.20	.....	5.70	4.40	3.50	.90	.85	1.35	1.20
9	1.60	(a)	2.10	.....	5.85	4.20	3.40	.85	.85	1.40	1.20
10	1.60	(a)	2.00	.....	5.90	4.20	3.30	.80	.90	1.35	1.20
11	1.70	(a)	1.90	.....	6.00	4.10	3.25	.70	1.05	1.35	1.20
12	1.70	(a)	1.90	.....	6.10	3.50	2.20	.70	1.10	1.35	1.25
13	1.70	(a)	1.75	1.70	6.20	3.60	3.10	.70	1.15	1.30	1.25
14	1.65	(a)	1.75	1.75	6.90	3.70	3.00	.60	1.20	1.30	1.25
15	1.65	(a)	1.80	1.80	7.20	3.80	2.80	.55	1.50	1.30	1.15
16	1.90	1.60	1.80	1.80	7.40	3.80	2.70	.50	1.50	1.30	1.15
17	1.70	1.60	1.80	1.85	7.60	3.85	2.60	.50	1.50	1.25	1.20
18	1.60	1.70	1.85	.....	7.85	3.90	2.40	.50	1.45	1.25	1.20
19	1.45	1.70	1.85	.....	7.80	4.00	2.40	.50	1.40	1.25	1.25
20	1.50	1.70	1.80	.....	7.50	4.10	2.30	.50	1.35	1.15	1.25
21	1.50	1.60	1.85	2.10	7.40	4.20	2.30	.50	1.30	1.15	1.25
22	1.60	1.50	1.80	2.25	7.00	4.45	3.20	.50	1.30	1.10	1.20
23	1.60	1.40	1.80	2.40	6.65	4.35	3.10	.50	1.30	1.10	1.20
24	1.50	1.40	.....	2.60	6.20	4.10	3.00	.55	1.30	1.10	1.15
25	1.50	1.40	1.70	2.85	6.00	3.95	3.00	.50	1.30	1.05	1.10
26	1.60	2.30	1.65	2.90	5.55	3.70	2.90	.50	1.30	1.05	1.10
27	1.50	2.40	1.65	.....	6.20	3.45	2.80	.50	1.30	1.05	1.15
28	1.45	2.50	1.60	2.80	7.00	3.20	1.65	.50	1.30	1.10	1.15
29	1.30	.....	1.60	2.95	7.50	3.50	1.50	.50	1.25	1.05	1.20
30	1.20	.....	1.65	3.50	8.55	3.70	1.40	.50	1.20	1.05	1.20
31	1.10	.....	1.65	.....	7.45	.....	1.35	.50	.....	1.05	.....

[a] Ice.

FLATHEAD LAKE AT POLSON, MONT.

This station, which is at the lower end of the lake, at the Polson post-office, was established by Prof. F. D. Smith on April 20, 1900. It is described in Water-Supply Paper No. 51, page 438. Readings were discontinued on June 30, 1901.

Daily gage height, in feet, of Flathead Lake at Polson, Mont., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	Day.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	3.90	.....	3.30	4.00	5.40	13.40	17	3.60	3.20	3.70	4.10	9.80	10.40
2	3.80	3.50	3.30	3.90	5.60	13.30	18	3.60	3.20	3.70	4.10	10.00	10.20
3	3.80	3.40	3.30	3.90	5.80	13.25	19	3.60	3.20	3.80	4.20	10.40	10.10
4	3.70	3.40	3.30	3.90	6.10	13.10	20	3.60	3.20	3.80	4.30	10.80	10.00
5	3.70	3.40	3.30	3.90	6.30	13.20	21	3.60	3.20	3.90	4.40	11.55	10.00
6	3.70	3.40	3.30	3.80	6.50	13.10	22	3.60	3.20	3.90	4.50	12.30	10.00
7	3.70	3.30	3.30	3.80	6.90	12.90	23	3.60	3.30	4.00	4.50	12.35	10.00
8	3.60	3.30	3.30	3.80	7.40	12.65	24	3.60	3.30	4.00	4.60	12.30	10.00
9	3.60	3.30	3.30	3.90	8.00	12.35	25	3.60	3.30	4.00	4.70	12.20	10.00
10	3.60	3.30	3.40	3.90	8.40	12.00	26	3.60	3.30	4.00	4.80	12.10	9.90
11	3.60	3.30	3.40	3.90	8.80	11.85	27	3.60	3.30	4.00	4.90	12.25	9.90
12	3.60	3.30	3.50	3.90	9.30	11.50	28	3.50	3.30	4.00	5.00	12.45	9.80
13	3.60	3.30	3.50	4.00	9.40	11.25	29	3.50	.....	4.00	5.10	12.70	9.70
14	3.60	3.20	3.60	4.00	9.40	10.95	30	3.50	.....	4.00	5.30	12.95	9.60
15	3.60	3.20	3.60	4.00	9.50	10.80	31	3.50	.....	4.00	.....	13.25	.....
16	3.60	3.20	3.60	4.00	9.60	10.55							

SPOKANE RIVER AT SPOKANE, WASH.

This station, established by C. C. Babb, October 17, 1896, is a short distance above Spokane Falls, at the bridge of the Oregon Railroad and Navigation Company. It is described in Water-Supply Paper No. 51, page 438. The results of measurements for 1890 will be found in the Twenty-second Annual Report, Part IV, page 443.

During 1901 new gages and bench marks were established at this point. The bench mark is a railroad spike driven into the electric-light pole close to and on the south side of the railroad track, at the west end of the bridge, at an elevation of 1,896.86 feet. The new wire gage on the north side of the west span of the bridge is the one used for recording the gage height. The zero of this gage is at an elevation of 1,879.35 feet, coinciding exactly with the position of the zero of old gage. As a safeguard, a new vertical gage rod has also been placed on the west face of the west pier of the bridge, the datum of which corresponds with that of the wire gage. No measurements of discharge were made at this station during 1901.

Daily gage height, in feet, of Spokane River at Spokane, Wash, for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	5.80	4.45	5.45	5.60	6.30	8.35	4.90	2.70	1.90	[a]1.85	1.70	2.75
2	5.60	4.25	6.20	5.55	6.55	8.20	4.80	2.65	1.90	[a]1.85	1.70	2.75
3	5.40	4.15	7.00	5.50	6.85	8.05	4.75	2.60	1.90	[a]1.85	1.70	2.75
4	5.30	4.00	7.70	5.45	7.25	7.90	4.70	2.55	1.90	[a]1.85	1.75	2.85
5	5.15	3.90	8.10	5.40	7.50	7.70	4.55	2.50	1.90	[a]1.85	1.75	2.90
6	5.05	3.80	8.25	5.35	7.70	7.50	4.50	2.50	1.85	[a]1.85	1.75	2.95
7	4.90	3.70	8.20	5.30	7.85	7.30	4.40	2.50	1.85	[a]1.85	1.75	3.00
8	4.80	3.60	8.15	5.25	8.00	7.10	4.35	2.45	1.80	[a]1.85	1.75	3.00
9	4.65	3.55	8.05	5.20	8.10	6.90	4.30	2.45	1.80	[a]1.85	1.75	3.00
10	4.50	3.50	7.80	5.10	8.20	6.80	4.20	2.40	1.80	1.85	1.85	3.00
11	4.50	3.40	7.70	5.00	8.30	6.65	4.15	2.35	1.80	1.85	1.85	3.00
12	4.35	3.35	7.50	5.00	8.35	6.45	4.05	2.30	1.80	1.75	1.85	3.00
13	4.30	3.25	7.35	5.05	8.40	6.20	4.00	2.25	1.80	1.75	1.85	3.00
14	4.70	3.20	7.10	5.10	8.45	6.10	3.85	2.20	1.80	1.75	1.85	2.95
15	5.20	3.20	6.90	5.30	8.60	6.05	3.70	2.15	1.80	1.80	1.85	2.90
16	5.55	3.35	6.75	5.40	8.70	5.90	3.70	2.15	1.80	1.80	1.80	2.85
17	5.75	3.65	6.55	5.45	8.85	5.85	3.55	2.10	1.80	1.80	1.80	2.80
18	5.80	4.30	6.50	5.45	9.00	5.75	3.45	2.10	1.80	1.75	1.85	2.85
19	5.80	4.60	6.35	5.50	9.10	5.70	3.40	2.05	1.85	1.75	1.85	2.70
20	5.75	4.75	6.25	5.60	9.10	5.70	3.35	2.05	1.85	1.70	1.80	2.65
21	5.65	4.80	6.15	5.65	9.10	5.65	3.30	2.05	1.85	1.70	1.80	2.60
22	5.50	4.85	6.10	5.70	9.00	5.60	3.25	2.05	1.80	1.70	1.80	2.60
23	5.40	4.80	6.10	5.85	8.85	5.55	3.20	2.05	1.80	1.70	1.80	2.60
24	5.25	4.80	6.10	5.95	8.75	5.45	3.10	2.05	1.80	1.70	2.25	2.70
25	5.15	4.75	6.05	6.05	8.70	5.35	3.05	2.05	1.85	1.65	2.30	3.00
26	5.05	4.75	6.05	6.20	8.60	5.30	3.00	2.00	1.80	1.65	2.50	3.20
27	4.95	4.85	6.00	6.20	8.55	5.25	2.95	2.00	1.80	1.65	2.60	3.20
28	4.80	5.10	5.90	6.20	8.55	5.25	2.90	2.00	1.80	1.65	2.65	3.25
29	4.70	.....	5.85	6.20	8.60	5.15	2.80	1.95	1.80	1.70	2.65	3.30
30	4.55	.....	5.75	6.20	8.65	5.00	2.80	1.95	1.85	1.70	2.70	3.25
31	4.45	.....	5.70	.....	8.55	.....	2.75	1.95	.....	1.70	.....	3.20

[a] Estimated; gage destroyed.

NACHES RIVER NEAR NORTH YAKIMA, WASH.

The original station on this river was established August 14, 1893. It was abandoned in 1897, and another was established February 1, 1898. It is described in Water-Supply Paper No. 51, page 440. Results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 444. A measurement was made by

Sydney Arnold, on April 25, 1901, when the discharge was found to be 2,275 second-feet and the gage height 7 feet.

Daily gage height, in feet, of Naches River near North Yakima, Wash., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	6.40	6.10	9.40	6.70	7.50	8.60	7.20	6.20	5.40	5.30	5.30	6.80
2	6.40	6.10	9.50	6.70	7.70	8.60	7.20	6.10	5.30	5.30	5.30	6.90
3	6.40	6.10	9.20	6.70	7.80	8.70	7.20	6.10	5.30	5.30	5.30	6.90
4	6.40	6.10	8.80	6.70	7.90	8.50	7.10	6.10	5.30	5.20	5.30	7.10
5	6.40	6.00	8.40	6.70	7.90	8.30	7.10	6.10	5.20	5.20	5.50	7.10
6	6.30	6.00	8.20	6.60	7.90	7.80	7.10	6.10	5.20	5.20	5.70	7.00
7	6.30	5.50	8.00	6.60	8.00	7.70	7.20	6.00	5.20	5.20	5.70	7.00
8	6.20	5.90	7.90	6.60	8.00	7.60	7.30	6.00	5.20	5.20	5.70	6.90
9	6.10	5.90	7.70	6.60	7.90	7.40	7.30	5.90	5.20	5.10	5.60	6.80
10	6.00	5.90	7.50	6.60	7.90	7.30	7.20	5.80	5.20	5.10	5.60	6.50
11	6.00	5.90	7.40	6.60	7.90	7.30	7.10	5.80	5.20	5.10	5.50	6.20
12	6.20	5.90	7.30	7.00	8.30	7.30	7.10	5.70	5.20	5.10	5.50	6.00
13	7.00	5.90	7.20	7.10	8.60	7.30	7.00	5.70	5.20	5.10	5.50	6.00
14	7.80	5.90	7.10	7.10	8.80	7.20	6.90	5.70	5.20	5.10	5.50	6.00
15	7.60	6.50	7.00	7.10	8.80	7.40	6.80	5.70	5.20	5.10	5.50	6.00
16	7.40	7.40	6.90	7.10	8.90	7.50	6.80	5.70	5.20	5.10	5.50	5.90
17	7.10	7.30	6.90	7.20	9.20	7.60	6.80	5.70	5.20	5.10	5.40	5.90
18	6.90	7.10	7.00	7.20	9.00	7.80	6.80	5.60	5.20	5.10	5.40	5.90
19	6.80	6.90	7.00	7.30	8.70	8.10	6.70	5.40	5.20	5.10	5.40	5.80
20	6.70	6.80	7.00	7.30	8.30	8.60	6.70	5.40	5.20	5.10	5.40	5.80
21	6.60	6.70	7.10	7.30	8.10	8.40	6.70	5.30	5.20	5.10	5.60	5.80
22	6.60	6.70	7.10	7.30	8.00	8.30	6.60	5.30	5.20	5.10	6.40	6.10
23	6.50	6.80	7.10	7.30	7.90	8.00	6.60	5.30	5.20	5.10	8.60	6.40
24	6.40	6.80	7.00	7.20	7.80	7.70	6.60	5.30	5.20	5.10	8.80	7.80
25	6.40	6.80	7.00	7.20	7.80	7.50	6.50	5.40	5.30	5.10	7.00	7.60
26	6.30	6.90	7.00	7.10	8.40	7.30	6.50	5.60	5.30	5.10	6.70	7.00
27	6.30	7.80	6.90	7.10	9.00	7.30	6.40	5.60	5.30	5.10	6.70	6.90
28	6.20	8.00	6.90	7.10	9.40	7.30	6.30	5.50	5.30	5.10	6.60	6.70
29	6.20	.....	6.80	7.20	9.30	7.30	6.20	5.50	5.30	5.10	6.60	6.60
30	6.20	.....	6.70	7.30	9.00	7.20	6.20	5.40	5.30	5.10	6.60	6.50
31	6.20	.....	6.70	.....	8.80	.....	6.20	5.40	.....	5.20	.....	6.40

NOTE.—Sunday readings estimated.

TIETON RIVER, WASHINGTON.

This stream is the principal tributary of the Naches River and discharges into the latter about 17 miles above its junction with the Yakima River, near North Yakima.

Its source is in the Cascade Mountains in the vicinity of Cowlitz Pass. A peculiar feature of the stream is the turbid, milk-white appearance of the water, it being similar in this respect to White River, on the western slope of the Cascade Range. The water of the South Fork of the Tieton, 25 miles above the mouth, is, however, perfectly clear. The forks head in the glaciers of a peak of the Cascades known locally as Goat Rock.

The capacity of the Tieton is considerable, being probably equal to about two-thirds that of the Upper Naches, averaging during the year 1,000 cubic feet per second. No measurements of the discharge have as yet been made, owing to the natural obstacles met with. The above estimate shows the great value of the Tieton for irrigation purposes. Its waters are, however, at present not used above where they mingle with those of the Naches River, since the great depth, narrowness, and rapid fall of the canyon through which the Tieton runs, together with the very limited area of its bottom land, render it a difficult problem to convey water to the uplands, except at great expense for fluming. There is little doubt that at some future period some of the plans pro-

posed for conveying water from the Tieton River to valuable lands in the Upper Cowiche district will be carried out.

Settlements on the river are now very few, for the reasons above given. Very fine bottom lands of somewhat limited extent are to be found 24 miles above the river mouth, but owing to their inaccessibility, except by mountain trail, they are used almost solely for stock grazing. A remarkable soda spring is to be found 4 miles below the river forks, the water of which is very palatable. During a summer reconnaissance of the river from its mouth to the headwaters it was found that the country is used to some extent for stock grazing, but no sheep were seen. Although no rain had fallen during July, August, and September, the vegetation had suffered but very little.

No locations suitable for reservoir sites were found, and it is believed that none exist on Tieton River proper.

YAKIMA RIVER AT UNION GAP, WASH.

The gaging station at Union Gap was established August 14, 1893. It is 6 miles below North Yakima, about 1,000 feet below the highway bridge, and about 3 miles above the head gate of the Sunnyside Canal. It is described in Water-Supply Paper No. 51, page 441. The station is of value in determining the amount of water available for the extensive irrigable lands below. The results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 447. No measurements of discharge were made at this station during 1901.

Daily gage height, in feet, of Yakima River at Union Gap, Wash., for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	6.10	5.60	10.10	6.20	7.20	9.00	7.00	5.50	4.40	4.40	4.20	6.60
2	6.10	5.60	11.20	6.20	7.40	8.90	6.90	5.50	4.40	4.40	4.20	6.60
3	6.10	5.60	10.90	6.30	7.60	9.00	1.90	5.40	4.40	4.30	4.40	6.90
4	6.10	5.50	10.10	6.30	7.80	9.00	6.90	5.30	4.40	4.30	4.60	7.00
5	6.00	5.50	9.30	6.40	7.90	9.00	6.90	5.30	4.40	4.30	4.90	7.00
6	6.00	5.40	8.70	6.30	8.00	8.30	6.80	5.30	4.40	4.30	5.00	7.00
7	5.90	5.30	8.50	6.30	8.00	8.00	6.70	5.20	4.40	4.30	5.60	7.00
8	5.80	5.30	8.20	6.20	8.00	7.60	6.90	5.20	4.40	4.30	5.80	7.00
9	5.70	5.20	8.00	6.20	7.90	7.30	6.90	5.10	4.40	4.20	5.70	6.80
10	5.60	5.20	7.50	6.30	7.90	7.10	6.80	5.10	4.40	4.20	5.70	6.60
11	5.60	5.20	7.20	6.40	7.80	7.00	6.70	5.00	4.40	4.20	5.60	6.60
12	5.70	5.20	7.20	6.60	7.90	7.00	6.60	5.00	4.30	4.20	5.40	6.40
13	7.70	5.20	7.10	7.00	8.60	7.10	6.50	4.90	4.30	4.20	5.20	6.40
14	7.60	5.40	6.90	7.00	9.00	7.10	6.40	4.90	4.30	4.20	5.20	6.30
15	7.60	5.80	6.80	7.00	9.60	7.10	6.30	4.80	4.30	4.10	5.40	6.10
16	7.40	6.50	6.80	6.90	9.60	7.00	6.30	4.80	4.30	4.10	5.60	6.00
17	7.40	7.10	6.80	6.90	9.60	7.10	6.30	4.70	4.30	4.20	5.60	5.90
18	6.80	6.70	6.80	6.90	10.00	7.50	6.20	4.70	4.30	4.20	5.60	5.80
19	6.60	6.50	6.80	6.80	9.40	7.80	6.20	4.60	4.20	4.20	5.50	5.80
20	6.60	6.30	6.80	6.70	9.00	8.20	6.10	4.60	4.20	4.20	5.40	5.70
21	6.50	6.20	6.80	6.90	8.50	8.30	6.10	4.60	4.20	4.20	5.40	5.60
22	6.40	6.10	6.90	6.90	8.10	8.30	6.10	4.50	4.20	4.20	5.40	5.90
23	6.30	6.10	6.90	7.00	7.90	8.00	6.00	4.50	4.30	4.30	5.40	6.60
24	6.20	6.00	6.90	7.00	7.80	7.80	6.00	4.50	4.40	4.30	6.00	8.60
25	6.10	6.20	6.80	6.90	7.90	7.60	6.00	4.50	4.50	4.30	6.60	8.80
26	6.00	6.60	6.70	6.80	8.60	7.20	6.00	4.50	4.60	4.30	6.60	8.60
27	5.90	7.90	6.60	6.70	7.50	7.00	5.90	4.40	4.60	4.30	6.40	8.00
28	5.90	8.30	6.50	6.70	9.10	7.00	5.80	4.40	4.60	4.30	6.40	7.60
29	5.80	.....	6.40	6.80	10.10	7.00	5.80	4.40	4.50	4.20	6.60	7.00
30	5.80	.....	6.30	6.90	10.40	7.00	5.80	4.40	4.40	4.20	6.50	7.00
31	5.70	.....	6.30	.....	9.40	.....	5.60	4.40	.....	4.20	.....	6.90

YAKIMA RIVER AT KIONA, WASH.

This station, established August 20, 1895, is on the highway bridge at Kiona. It is described in Water-Supply Paper No. 51, page 442. Results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 448. A new bench mark was established during 1901. It is the top of an iron spike in the east end of the cap of the first trestle bent of the bridge approach on the south side of the river. The top of the 2-inch pulley wheel of the wire gage is 4.68 feet above this bench mark. The length of the gage wire is 27.21 feet and the pulley distance 2 feet.

A measurement was made by Sydney Arnold on May 16, when the discharge was found to be 16,781 second-feet and the gage height 11.50 feet.

Daily gage height, in feet, of Yakima River at Kiona, Wash., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	7.70	6.96	11.33	7.95	8.65	11.10	7.11	4.93	3.45	3.55	4.23	6.70
2	7.35	6.90	12.75	7.90	9.23	10.93	7.00	4.75	3.45	3.57	4.30	6.85
3	7.28	6.86	13.43	7.90	9.45	10.63	6.80	4.85	3.35	3.60	4.30	6.85
4	7.25	6.75	14.00	7.82	9.75	10.45	6.75	5.01	3.30	3.60	4.35	6.75
5	7.25	6.64	13.33	7.75	9.80	10.25	6.70	5.05	3.25	3.60	4.47	6.69
6	7.20	6.58	12.48	7.65	9.90	9.85	6.65	5.00	3.25	3.58	4.55	6.55
7	7.18	6.55	11.50	7.50	10.10	9.75	6.59	4.97	3.20	3.55	4.63	6.50
8	7.15	6.50	11.13	7.50	10.20	9.60	6.59	4.90	[a]3.20	3.55	4.70	6.38
9	7.08	6.42	10.58	7.45	10.15	9.35	6.55	4.85	[a]3.20	3.55	4.80	6.25
10	7.05	6.36	10.18	7.60	10.00	9.05	6.55	4.77	[a]3.20	3.53	4.88	6.17
11	7.10	6.30	9.98	7.68	10.15	8.50	6.49	4.65	[a]3.20	3.52	4.95	6.05
12	7.12	6.26	9.70	7.75	10.20	8.05	6.45	4.56	[a]3.20	3.50	5.05	5.85
13	7.15	6.28	9.45	8.45	10.25	7.55	6.43	4.50	[a]3.25	3.50	4.95	5.65
14	8.75	6.30	9.18	8.52	10.40	7.35	6.40	4.40	[a]3.25	3.50	5.75	5.65
15	10.45	6.75	8.90	8.60	11.05	7.45	6.30	4.35	[a]3.25	3.55	5.87	5.60
16	10.25	7.00	8.75	8.65	11.50	7.60	6.17	4.20	[a]3.25	3.55	6.00	5.45
17	9.93	8.08	8.70	8.72	11.50	7.80	6.05	4.15	[a]3.25	3.60	6.15	5.40
18	9.50	8.90	8.70	8.78	11.60	8.05	5.97	4.13	[a]3.30	3.60	6.35	5.25
19	9.00	9.10	8.68	8.70	11.80	8.25	5.95	4.10	[a]3.30	3.65	6.75	5.15
20	8.75	8.90	8.68	8.65	11.80	8.50	5.93	4.01	[a]3.30	3.80	7.00	5.08
21	8.50	8.20	8.65	8.60	11.25	8.85	5.85	3.94	[a]3.30	3.85	7.25	5.05
22	8.28	8.30	8.65	8.50	10.95	9.10	5.80	3.85	3.30	3.85	7.40	5.40
23	7.89	8.42	8.63	8.42	10.35	8.55	5.85	3.75	3.35	3.95	7.60	5.75
24	7.80	8.45	8.60	8.36	9.90	8.50	5.90	3.75	3.35	3.97	7.65	6.50
25	7.70	8.50	8.60	8.28	10.20	8.15	5.85	3.65	3.40	3.97	7.55	7.65
26	7.59	8.55	8.38	8.20	10.60	7.85	5.70	3.63	3.40	4.00	7.40	9.10
27	7.42	10.23	8.30	8.26	11.30	7.51	5.60	3.60	3.41	4.05	7.11	8.55
28	7.30	10.83	8.25	8.33	11.85	7.35	5.45	3.55	3.45	4.15	6.90	8.55
29	7.20	.....	8.25	8.45	12.20	7.30	5.40	3.55	3.45	4.15	6.55	8.60
30	7.12	.....	8.20	8.52	12.90	7.15	5.25	3.53	3.48	4.15	6.65	8.62
31	7.00	.....	8.00	.....	11.35	.....	5.10	3.50	.....	4.20	.....	8.60

[a] Gage heights estimated.

PALOUSE RIVER NEAR HOOPER, WASH.

This station, established September 9, 1897, is opposite the water tank of the railroad company near Hooper. It is described in Water-Supply Paper No. 51, page 443. Results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 452. During 1901 no measurements were made at this station.

Daily gage height, in feet, of Palouse River near Hooper, Wash., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.45	3.70	9.40	4.40	3.50	2.75	2.50	1.20	0.50	0.90	0.90	1.65
2	3.55	3.50	9.40	4.30	3.50	2.60	2.50	1.20	.50	.90	.90	1.50
3	3.50	3.50	10.10	4.90	3.60	2.50	2.50	1.10	.50	.85	.90	1.50
4	3.60	3.20	10.65	4.90	3.70	2.40	2.45	1.10	.50	.80	.95	1.50
5	3.70	3.10	10.20	5.10	3.70	2.30	2.45	1.10	.55	.80	.95	1.85
6	3.60	3.00	8.10	5.10	3.65	2.30	2.40	1.10	.60	.80	1.10	1.90
7	3.50	3.10	7.20	5.00	3.50	2.30	2.40	1.05	.70	.80	1.15	1.90
8	3.45	3.00	7.20	5.30	3.30	2.30	2.40	1.05	.75	.85	1.20	1.90
9	3.50	2.90	7.20	5.30	3.30	2.30	2.40	1.05	.80	.85	1.20	1.90
10	3.40	2.80	7.30	5.20	3.20	2.30	2.35	1.05	.80	.90	1.30	2.00
11	3.40	2.80	7.20	5.00	3.10	2.40	2.30	1.00	.80	.85	1.40	2.00
12	3.90	2.70	6.60	4.70	3.10	2.55	2.20	.95	.80	.80	1.30	1.90
13	5.25	2.70	6.30	4.80	3.05	2.80	2.20	.90	.85	.80	1.25	1.80
14	7.60	2.70	6.10	4.80	3.00	2.90	2.10	.85	.85	.80	1.25	1.70
15	8.95	2.80	5.80	4.90	2.90	3.00	2.10	.85	.80	.80	1.20	1.60
16	8.65	4.80	5.50	4.80	2.90	3.10	2.10	.80	.80	.75	1.15	1.60
17	8.20	10.50	5.30	4.60	2.80	3.15	2.00	.80	.80	.75	1.10	1.55
18	7.25	9.80	5.30	4.20	2.80	3.20	2.00	.70	.75	.75	1.10	1.50
19	6.00	9.80	5.30	4.10	2.70	3.10	2.00	.70	.75	.75	1.10	1.40
20	5.50	7.75	5.30	4.10	2.80	3.10	1.90	.70	.75	.80	1.10	1.40
21	5.20	8.30	5.20	4.20	2.70	3.05	1.90	.70	.75	.80	1.10	1.35
22	4.80	7.30	4.90	4.30	2.70	3.90	1.90	.65	.75	.80	1.15	1.40
23	4.65	6.60	5.20	4.30	2.85	2.90	1.85	.65	.70	.80	1.25	1.45
24	4.70	6.40	5.30	4.50	2.90	2.80	1.80	.60	.70	.80	1.30	1.50
25	4.55	6.50	5.50	4.40	2.95	2.75	1.70	.60	.75	.80	1.45	2.50
26	4.50	7.00	5.30	4.20	3.00	2.60	1.55	.60	.75	.80	2.20	3.30
27	4.20	8.20	5.10	4.00	2.90	2.50	1.45	.55	.80	.80	2.10	3.50
28	4.20	9.10	4.90	4.00	2.80	2.50	1.40	.55	.80	.80	2.00	3.30
29	4.20	.....	4.70	3.90	2.80	2.50	1.35	.55	.85	.85	1.90	2.80
30	4.10	.....	4.60	3.80	2.70	2.50	1.30	.55	.90	.85	1.80	2.50
31	3.90	.....	4.40	.....	2.90	.....	1.20	.50	.....	.85	.....	2.40

UMATILLA RIVER AT GIBBON, OREG.

This station, established July 26, 1896, is a half mile west of the railroad station. It is described in Water-Supply Paper No. 51, page 444. Results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 453. No measurements of discharge were made at this point during 1901.

Daily gage height, in feet, of Umatilla River at Gibbon, Oreg., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.75	1.60	5.45	3.05	3.50	1.70	1.00	0.60	0.35	0.75	0.85	0.90
2	1.70	1.60	5.40	3.00	3.50	1.60	1.00	.55	.35	.75	.80	.90
3	1.70	1.55	4.90	3.00	3.50	1.50	1.00	.55	.35	.75	.80	.90
4	1.70	1.45	4.35	2.95	3.55	1.40	1.00	.55	.40	.75	.80	.95
5	1.65	1.40	3.90	2.95	3.55	1.40	1.00	.50	.40	.75	.80	1.00
6	1.60	1.35	3.70	2.90	3.55	1.35	.95	.50	.45	.75	.80	1.20
7	1.50	1.30	3.85	2.85	3.55	1.40	.95	.50	.45	.75	.80	1.30
8	1.45	1.25	3.85	2.80	3.60	1.40	.95	.50	.50	.75	.80	1.50
9	1.40	1.20	3.75	2.75	3.75	1.40	.95	.50	.50	.80	.85	1.60
10	1.35	1.15	3.65	2.80	3.75	1.40	.95	.45	.50	.80	.85	1.55
11	1.30	1.15	3.55	3.10	3.80	1.35	.90	.45	.55	.75	.85	1.55
12	1.95	1.10	3.40	3.60	3.70	1.30	.90	.45	.55	.75	.80	1.55
13	3.95	1.10	3.40	3.95	3.60	1.30	.90	.45	.55	.75	.80	1.50
14	4.70	1.10	3.35	3.85	3.45	1.25	.80	.45	.60	.75	.80	1.50
15	3.90	1.10	3.30	3.60	3.20	1.30	.80	.45	.60	.75	.80	1.50
16	3.30	5.75	3.30	3.35	3.05	1.35	.80	.40	.60	.75	.80	1.50
17	3.00	4.65	3.25	3.45	2.90	1.35	.80	.40	.60	.75	.80	1.45
18	2.85	3.85	3.15	3.35	2.85	1.45	.75	.40	.65	.75	.80	1.45
19	2.75	3.40	3.05	3.55	2.75	1.45	.75	.40	.65	.75	.80	1.50
20	2.60	3.15	3.00	3.55	2.70	1.40	.75	.40	.65	.75	.85	1.50
21	2.50	2.85	2.95	3.55	2.60	1.30	.75	.40	.65	.75	.85	1.95
22	2.35	2.75	3.15	3.65	2.50	1.30	.75	.40	.70	.80	.85	1.85
23	2.25	2.75	3.00	3.65	2.45	1.30	.75	.35	.70	.80	.85	1.70
24	2.10	3.30	2.90	3.65	2.35	1.25	.70	.35	.70	.80	.85	1.70
25	2.00	4.00	2.85	3.50	2.20	1.25	.70	.35	.75	.80	.85	1.65
26	1.90	4.20	2.80	3.35	2.10	1.20	.70	.35	.75	.80	.85	1.65
27	1.90	5.95	2.80	3.30	2.10	1.20	.70	.35	.75	.80	.85	1.65
28	1.80	5.75	2.85	3.10	2.00	1.10	.65	.35	.75	.80	.85	1.60
29	1.70	.....	2.85	3.10	1.90	1.10	.65	.35	.75	.85	.90	1.50
30	1.70	.....	2.95	3.25	1.90	1.05	.60	.35	.75	.85	.90	1.45
31	1.65	.....	2.95	.....	1.80	.....	.60	.35	.....	.85	.....	1.35

WHITE RIVER NEAR BUCKLEY, WASH.

This station, established April 22, 1899, is at the new highway bridge, 500 feet above the Northern Pacific Railway bridge and a half mile north of the town of Buckley. It is described in Water-Supply Paper No. 51, page 445. During 1901 no measurements were made at this station.

Daily gage height, in feet, of White River near Buckley, Wash., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.25	0.95	4.25	1.45	1.35	2.30	1.70	1.25	0.70	0.20	0.90	2.30
2	1.20	.90	3.75	1.75	1.60	2.55	1.70	1.25	.65	.20	.65	2.00
3	1.15	.90	2.85	1.40	1.55	2.40	1.70	1.25	.65	.20	.80	1.80
4	1.10	.85	2.35	1.25	1.50	2.20	1.65	1.25	.65	.25	1.60	1.80
5	1.10	.80	2.10	1.20	1.50	1.90	1.65	1.25	.60	.25	1.45	1.60
6	1.00	.80	1.85	1.15	1.45	1.75	1.80	1.25	.50	.25	1.05	1.45
7	1.00	.80	1.75	1.10	1.45	1.70	1.90	1.20	.40	.25	1.25	1.40
8	.95	.75	1.65	1.00	1.60	1.60	1.90	1.15	.35	.30	1.00	2.05
9	.90	.75	1.60	.95	1.60	1.55	1.80	1.10	.35	.30	.90	2.00
10	.90	.70	1.45	.90	1.50	1.50	1.75	1.00	.30	.25	.85	1.95
11	1.05	.70	1.35	1.55	1.55	1.50	1.70	.95	.30	.35	.70	1.40
12	1.75	.70	1.30	1.70	1.95	1.45	1.55	.95	.40	.35	1.15	1.25
13	4.95	.80	1.20	1.55	2.20	1.60	1.50	1.00	.50	[a].30	1.05	1.20
14	3.40	1.15	1.15	1.45	2.20	1.60	1.45	1.15	.50	[a].30	.85	1.20
15	2.60	1.90	1.10	1.30	2.10	1.50	1.45	1.20	.45	.20	.80	1.05
16	2.10	4.80	1.10	1.20	2.60	1.60	1.60	1.30	.40	.20	.70	.95
17	1.70	3.08	1.15	1.15	2.90	1.80	1.60	1.15	.40	.20	.70	.90
18	1.60	2.15	1.15	1.15	2.50	2.10	1.50	1.05	.40	.25	.70	1.05
19	1.55	1.80	1.10	1.15	2.20	2.40	1.50	.95	.40	.25	.60	1.05
20	1.45	1.60	1.10	1.30	1.95	2.50	1.50	.85	.40	.40	.70	1.05
21	1.45	1.40	1.05	1.30	1.75	2.40	1.45	.80	.60	.50	.90	1.00
22	1.45	1.30	1.10	1.15	1.70	2.15	1.70	.80	.60	.45	5.90	1.55
23	1.40	1.30	1.10	1.15	1.60	2.00	1.70	.90	.50	.40	4.30	3.50
24	1.30	1.65	1.00	1.15	1.55	1.85	1.65	1.00	.40	.35	2.70	2.80
25	1.15	1.75	1.00	1.10	1.80	1.70	1.55	1.05	.35	.30	2.05	2.40
26	1.15	1.90	1.10	1.10	2.60	1.60	1.40	1.10	.40	.30	1.85	2.20
27	1.10	2.60	1.10	1.05	2.90	1.70	1.30	.85	.40	.55	1.70	1.75
28	1.10	3.35	1.05	1.00	2.90	1,80	1.30	.70	.30	.40	1.60	1.50
29	1.05	.....	1.05	1.10	2.80	1.80	1.25	.70	.25	.40	1.50	1.50
30	1.00	.....	1.05	1.25	2.40	1.80	1.30	.70	.20	.55	1.30	1.20
31	.95	.....	1.10	.....	2.25	.....	1.30	.70	.....	1.58	.....	1.20

[a] Estimated.

NORTHERN PACIFIC COAST DRAINAGE.

DUNGENESS RIVER AT DUNGENESS, WASH.

This station as originally established, July 5, 1897, was 9 miles above the mouth of the river. On July 29, 1898, it was moved to the bridge 8½ miles down stream, or near the mouth. It is described in Water-Supply Paper No. 51, page 446. Results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 458. The station was discontinued December 31, 1901. During 1901 the following measurements were made by W. J. Ware:

List of discharge measurements of Dungeness River at Dungeness, Wash.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1901.	*Feet.*	*Sec.-ft.*	1901.	*Feet.*	*Sec.-ft.*
January 4	3.60	3.53	August 29	4.40	269
February 26 [a]	4.10	471.4	September 28	4.05	147
March 19 [a]	4.05	252	October 31	4.10	185
April 30	4.00	289	November 29	6.05	1,250
May 27	5.80	1,212	December 27	4.35	390
July 31	5.80	658			

[a] Seeming discrepancies due to formation of sand bar.

Daily gage height, in feet, of Dungeness River at Dungeness, Wash., for 1901.

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	3.90	4.15	5.70	4.90	4.80	4.45	4.05	4.05	6.00
2	.....	4.00	4.20	5.65	4.95	4.80	4.40	4.05	4.05	5.50
3	.....	4.05	4.30	5.60	5.00	4.80	4.40	4.05	4.10	5.40
4	.....	4.10	4.40	5.60	5.00	4.80	4.35	4.05	4.10	5.20
5	.....	4.15	4.50	5.55	5.15	4.80	4.35	4.05	4.10	5.00
6	.....	4.20	4.60	5.50	5.20	4.80	4.30	4.05	4.10	4.80
7	.....	4.30	4.90	5.45	5.20	4.75	4.30	4.05	4.05	4.70
8	.....	4.40	4.90	5.40	5.15	4.75	4.30	4.05	4.05	4.65
9	.....	4.50	5.00	5.30	5.10	4.70	4.30	4.05	4.05	4.60
10	.....	4.45	5.10	5.30	5.05	4.70	4.25	4.05	4.15	4.55
11	.....	4.40	5.20	5.25	5.00	4.80	4.25	4.05	4.25	4.50
12	.....	4.35	5.10	5.20	4.90	4.75	4.20	4.05	4.40	4.45
13	.....	4.30	5.10	5.20	4.80	4.75	4.20	4.05	4.55	4.40
14	.....	4.30	5.15	5.15	4.80	4.70	4.20	4.10	4.70	4.40
15	.....	4.25	5.10	5.10	4.75	4.70	4.20	4.15	4.65	4.35
16	.....	4.20	6.20	5.05	4.70	4.65	4.20	4.20	4.60	4.30
17	.....	4.20	5.90	5.00	4.75	4.60	4.20	4.25	4.55	4.30
18	4.05	4.15	5.80	5.05	4.80	4.60	4.25	4.30	4.50	4.25
19	4.05	4.15	5.70	5.05	4.80	4.55	4.25	4.30	4.60	4.25
20	4.00	4.10	5.60	5.05	4.85	4.55	4.30	4.20	4.65	4.20
21	3.95	4.10	5.55	5.10	4.85	4.60	4.30	4.15	4.70	4.20
22	3.90	4.05	5.50	5.00	4.80	4.65	4.30	4.10	4.75	4.25
23	3.90	4.05	5.40	4.90	4.75	4.65	4.30	4.10	4.70	4.25
24	3.90	4.00	5.30	4.85	4.75	4.70	4.25	4.05	4.60	4.25
25	3.85	4.00	5.25	4.90	4.75	4.65	4.25	4.05	4.60	4.30
26	3.80	4.05	5.20	4.90	4.80	4.65	4.20	4.10	4.70	4.30
27	3.85	4.05	5.80	4.85	4.80	4.60	4.20	4.10	9.50	4.35
28	3.90	4.10	5.90	4.85	4.80	4.60	4.15	4.10	8.50	4.35
29	3.90	4.10	5.80	4.80	4.80	4.60	4.15	4.15	8.00	4.40
30	3.85	4.10	5.75	4.85	4.80	4.55	4.10	4.15	6.50	4.35
31	3.85	.....	5.75	.....	4.80	4.50	.....	4.10	.....	4.30

ELWHA RIVER AT McDONALD, WASH.

This station, established October 8, 1897, is at the new county bridge, 9 miles southwest of Port Angeles. It is described in Water-Supply Paper No. 51, page 447. Results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 459. The station was discontinued December 31, 1901. During 1901 the following measurements were made by W. J. Ware:

List of discharge measurements of Elwha River at McDonald, Wash.

Date.	Gage height.	Discharge.	Day.	Gage height.	Discharge.
1901.	*Feet.*	*Sec.-ft.*	1901.	*Feet.*	*Sec.-ft.*
March 30	2.25	890	August 23	2.70	984
April 29	2.65	1,148	September 26	2.06	643
May 30	4.00	2,333	October 29	2.45	893
June 25	3.65	1,604	November 25	3.80	1,881
July 30	3.45	1,458			

Daily gage height, in feet, of Elwha River at McDonald, Wash., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.31	2.60	5.98	3.22	2.98	5.55	3.44	3.34	2.60	1.97	3.32	5.80
2	3.20	2.64	5.15	2.88	3.34	4.82	3.59	3.36	2.48	1.97	3.19	4.90
3	3.04	2.55	4.80	2.70	3.14	4.78	3.60	3.30	2.44	1.75	3.95	4.95
4	3.00	2.52	4.22	2.78	3.08	4.62	3.56	3.26	2.41	1.60	3.45	6.20
5	2.95	2.55	3.85	2.95	2.97	4.14	3.53	3.25	2.38	1.58	4.59	4.80
6	2.85	2.25	3.72	2.84	3.00	3.93	3.88	3.28	2.37	1.56	3.05	4.35
7	2.98	2.20	3.61	2.52	2.95	3.65	3.68	3.31	2.34	1.54	2.62	3.80
8	2.95	2.18	3.52	2.55	2.90	3.62	3.85	3.30	2.31	1.48	2.48	3.50
9	2.89	2.15	3.43	2.50	2.90	3.34	3.80	3.14	2.23	1.47	2.40	4.15
10	3.02	2.06	3.70	2.52	2.88	3.23	3.66	3.11	2.21	1.44	2.35	3.90
11	3.20	2.02	3.10	3.12	2.87	3.10	3.61	3.12	1.95	1.43	2.88	3.90
12	3.90	2.14	3.03	3.10	4.02	3.22	3.50	3.15	2.24	1.41	5.60	3.55
13	7.89	3.15	2.84	2.84	4.04	3.21	3.48	3.10	2.22	1.61	5.79	3.50
14	5.88	2.90	2.54	2.79	3.86	3.54	3.45	3.15	2.02	1.54	4.89	3.40
15	4.84	3.50	2.80	2.60	4.23	3.60	3.34	3.17	2.04	1.55	3.80	3.40
16	4.04	4.85	2.85	2.30	6.46	3.58	3.68	3.14	2.02	1.51	4.45	3.30
17	3.74	3.74	2.90	2.26	5.20	4.05	3.54	3.11	2.00	1.47	3.95	3.25
18	3.60	3.20	2.85	2.22	4.53	4.48	3.55	3.09	1.98	1.47	3.53	3.20
19	3.48	3.18	2.45	2.28	4.09	4.52	3.51	2.88	1.90	1.44	3.45	3.20
20	3.45	2.92	2.39	2.80	3.65	4.62	3.40	2.85	1.97	3.43	4.02	3.00
21	3.42	2.90	2.62	2.83	3.61	4.20	3.80	2.78	2.03	2.39	3.50	3.45
22	3.44	2.83	2.65	2.91	3.55	4.22	3.92	2.75	2.07	2.21	5.60	3.90
23	3.39	2.95	2.62	2.54	3.51	4.00	3.76	2.71	2.12	2.20	5.19	4.00
24	3.36	4.60	2.34	2.45	3.51	3.60	2.74	2.69	2.10	2.00	4.22	4.05
25	3.10	3.92	2.30	1.96	3.72	3.64	3.48	2.80	2.07	1.87	3.80	3.90
26	2.98	4.00	2.27	2.45	4.44	3.65	3.49	2.80	2.06	1.80	4.66	3.70
27	2.85	5.46	2.22	2.28	5.45	3.84	3.46	2.65	2.04	2.60	10.61	3.50
28	2.80	7.41	2.12	2.30	5.12	4.03	3.44	2.62	2.00	2.34	6.45	3.10
29	2.78	.....	2.50	2.65	4.56	3.71	3.25	2.61	2.04	2.44	6.10	3.00
30	2.72	.....	2.25	2.66	4.43	3.50	3.45	2.52	2.00	3.02	5.55	3.00
31	2.70	.....	2.31	.....	4.40	.....	3.41	2.54	.....	3.80	.....	2.85

KALAWA RIVER NEAR FORKS, WASH.

This station, established November 12, 1897, is at the county highway bridge in the southwestern part of Clallam County, near Forks, Wash. It is described in Water-Supply Paper No. 51, page 448. Results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 460. The station was discontinued December 31, 1901. During 1901 the following measurements were made by W. J. Ware:

List of discharge measurements of Kalawa River near Forks, Wash.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1901.	*Feet.*	*Sec.-ft.*	1901.	*Feet.*	*Sec.-ft.*
March 28	3.40	1,382	November 10	2.40	772
June 20	1.00	300	November 12	8.05	4,901
September 18	−.10	61	December 21	2.25	734

Daily gage height, in feet, of Kalawa River near Forks, Wash., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.05	1.85	8.45	3.20	2.60	1.85	1.00	0.40	0.00	0.00	4.20	6.30
2	1.80	1.90	7.25	4.80	2.65	2.05	1.00	.45	.50	.00	3.30	4.80
3	1.40	1.90	4.85	4.40	2.80	2.45	.85	.25	.00	.00	4.30	4.20
4	1.20	1.70	4.60	4.00	2.60	2.40	.80	.25	.00	.00	4.35	10.20
5	1.05	1.40	4.25	3.85	2.60	2.60	.80	.25	.00	.00	5.55	6.20
6	1.40	1.30	3.80	3.80	2.45	2.65	.65	.20	.00	.00	4.35	4.55
7	1.60	1.20	3.20	3.40	2.40	2.60	.65	.20	.00	.00	3.35	4.80
8	1.85	1.20	3.05	3.00	1.40	2.40	.60	.20	.00	.05	3.00	5.80
9	1.65	1.05	3.00	3.00	1.25	1.40	.60	.20	.00	.05	2.35	6.00
10	1.85	1.00	3.20	2.85	1.20	1.45	.60	.05	.00	.05	2.40	3.60
11	5.90	1.00	3.25	2.80	2.00	1.65	.60	.05	.00	.00	3.68	3.20
12	15.00	1.40	3.20	2.60	1.85	1.60	.45	.05	.05	.00	7.23	2.65
13	16.00	1.45	3.00	2.40	1.80	1.45	.45	.05	.20	.00	6.30	2.60
14	8.00	1.40	2.80	2.45	1.85	1.40	.40	.05	.05	.00	5.10	2.40
15	6.80	2.00	2.60	2.40	2.00	1.40	.45	.05	.05	.00	4.00	2.30
16	5.40	5.45	2.45	2.25	8.20	1.20	.45	.00	.00	.00	4.60	2.25
17	4.60	2.20	2.40	2.20	4.20	1.05	.45	.00	.00	.05	5.00	2.00
18	4.10	2.00	2.25	2.00	3.60	1.05	.45	.00	.00	.05	4.00	2.00
19	3.20	1.85	2.25	1.85	.....	1.05	.40	.00	.00	.05	3.35	1.95
20	2.40	1.60	2.00	2.00	.....	1.05	.40	.00	.00	3.20	3.40	1.85
21	2.20	1.25	1.85	2.00	2.00	1.05	.40	.00	.30	1.00	3.85	2.25
22	2.05	2.00	2.00	2.20	2.20	1.05	.40	.00	.25	.30	7.05	6.05
23	2.00	4.85	2.20	2.25	2.25	1.05	.45	.00	.20	.25	4.80	5.20
24	1.85	4.00	2.45	2.20	2.20	1.20	.45	.00	.05	.20	4.80	5.60
25	1.90	4.45	3.00	2.40	2.40	1.25	.45	.05	.20	.05	4.60	5.45
26	1.80	6.05	3.40	2.65	2.65	1.25	.40	.00	.05	.05	4.80	7.60
27	1.80	7.25	3.25	2.80	2.80	1.20	.40	.00	.05	.20	13.05	5.00
28	1.80	8.45	3.20	2.65	1.20	1.20	.45	.00	.05	.20	7.00	4.60
29	1.60	.....	2.80	2.65	1.05	1.05	.40	.00	.05	.20	4.80	3.55
30	1.65	.....	2.60	2.60	1.20	1.05	.40	.00	.00	2.05	5.20	3.30
31	1.70	.....	2.80	.....	1.05	.....	.40	.00	.....	5.25	.....	2.95

SOLEDUCK RIVER NEAR QUILLAYUTE, WASH.

This station, established November 13, 1887, is at the county highway bridge, 9 miles northeast of Lapush, near Quillayute. The station is described in Water-Supply Paper No. 51, page 449. Results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 461. The station was discontinued December 31, 1901. During 1901 the following measurements of discharge were made by W. J. Ware:

March 28: Gage height, 5.50 feet; discharge, 1,649 second-feet.
June 19: Gage height, 5.20 feet; discharge, 1,295 second-feet.
September 18: Gage height, 3.00 feet; discharge, 199 second-feet.
December 21: Gage height, 5.20 feet; discharge, 1,397 second-feet.

Daily gage height, in feet, of Soleduck River near Quillayute, Wash., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	5.90	4.90	10.70	6.50	5.35	5.90	4.50	3.85	3.25	3.05	8.20	8.75
2	5.70	4.80	8.30	7.30	5.25	5.80	4.45	3.80	3.25	3.00	5.80	7.90
3	5.60	4.80	7.70	6.75	5.30	5.75	4.45	3.80	3.20	3.00	6.60	7.10
4	5.45	4.75	6.95	6.20	5.30	5.60	4.40	3.80	3.20	2.95	7.40	10.80
5	5.30	4.65	6.50	6.35	5.10	5.60	4.45	3.75	3.15	2.95	6.85	8.70
6	5.25	4.60	6.30	6.50	5.00	5.55	4.45	3.75	3.15	3.00	6.40	7.40
7	5.10	4.55	6.00	6.20	4.95	5.55	4.35	3.70	3.10	3.05	5.90	6.90
8	5.00	4.50	5.90	5.80	4.90	5.40	4.35	3.70	3.10	3.10	5.70	9.40
9	5.15	4.45	5.80	5.50	4.85	5.20	4.30	3.70	3.10	3.00	5.30	7.60
10	5.40	4.40	5.70	5.60	4.80	5.10	4.30	3.65	3.05	2.95	6.20	7.10
11	6.00	4.30	5.60	5.75	4.75	5.10	4.35	3.65	3.10	2.95	8.30	6.60
12	11.40	4.35	5.50	5.75	5.50	4.90	4.30	3.60	3.05	2.90	11.60	6.20
13	12.70	4.40	5.40	5.70	5.45	4.80	4.25	3.60	3.05	2.90	8.80	5.90
14	11.40	4.90	5.30	5.55	5.40	4.80	4.15	3.55	3.00	2.90	7.40	5.70
15	10.15	5.40	5.15	5.30	5.50	4.75	4.10	3.55	3.00	2.85	7.10	5.55
16	8.90	8.30	5.10	5.25	7.80	4.80	4.10	3.55	3.05	2.80	6.60	5.40
17	7.30	6.60	5.10	5.20	7.65	4.90	4.15	3.50	3.00	2.80	7.15	5.35
18	6.80	6.25	5.10	5.10	6.70	4.95	4.10	3.50	3.05	2.85	7.05	5.15
19	6.50	5.30	5.00	5.30	6.10	5.20	4.10	3.45	3.00	2.85	6.80	5.10
20	6.40	5.50	4.90	5.70	5.80	5.00	4.05	3.40	3.15	3.70	6.65	5.00
21	6.30	5.15	4.90	5.90	5.65	4.90	4.05	3.40	3.20	3.55	6.40	5.90
22	6.10	5.25	4.85	6.40	5.40	4.75	4.10	3.35	3.25	3.40	7.90	7.50
23	5.90	5.40	4.90	6.70	5.30	4.70	4.10	3.35	3.20	3.25	7.65	7.50
24	5.75	6.60	5.00	6.40	5.15	4.60	4.10	3.30	3.20	3.20	7.30	7.55
25	5.60	7.40	5.05	5.90	5.00	4.60	4.05	3.30	3.20	3.20	6.90	7.75
26	5.50	7.10	5.40	5.70	5.90	4.65	4.00	3.30	3.15	3.10	6.60	8.00
27	5.50	8.75	5.90	5.30	6.00	4.60	3.95	3.25	3.10	3.25	13.70	7.40
28	5.35	10.30	5.55	5.35	6.10	4.65	3.95	3.25	3.10	3.60	9.60	7.60
29	5.20	.....	5.35	5.30	5.70	4.65	3.90	3.25	3.10	4.10	8.10	6.20
30	5.10	.....	5.15	5.35	5.20	4.55	3.90	3.20	3.05	4.55	7.70	5.90
31	5.00	.....	5.20	.....	5.40	.....	3.90	3.20	.....	6.90	.....	5.80

MISCELLANEOUS DISCHARGE MEASUREMENTS IN NORTHWESTERN WASHINGTON.

Date.	Stream.	Locality.	Hydrographer.	Discharge.
1901.				*Sec.-ft.*
March 8	Morse River	Near Port Angeles	Wm. J. Ware	173
May 1	do	do	do	169
August 1	do	do	do	122
August 29	do	do	do	78
September 28	do	do	do	50
February 28	Little River	Near McDonald	do	147
April 29	do	do	do	55
September 26	do	do	do	13
October 29	do	do	do	20
November 27	do	do	do	457
March 29	West Fork of Pysht River	At the forks	do	114
June 21	do	do	do	29
September 20	do	do	do	4
June 21	East Fork of Pysht River	do	do	19
March 29	Clallam River	Near East Clallam	do	100
June 21	do	do	do	12
September 20	do	do	do	6

SAN FRANCISCO BAY DRAINAGE.

SACRAMENTO RIVER AT JELLYS FERRY, CALIFORNIA.

This station, established April 30, 1895, is 12 miles above the town of Red Bluff, at Jellys Ferry. It is described in Water-Supply Paper No. 51, page 450. Results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 462. During 1901 the following measurements of discharge were made under the direction of J. B. Lippincott:

List of discharge measurements of Sacramento River at Jellys Ferry, California.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1901.	*Feet.*	*Sec.-ft.*	1901.	*Feet.*	*Sec.-ft.*
January 27	9.46	15,908	October 30	1.02	5,187
April 9	7.80	11,112	December 13	2.68	9,651
September 2	4.90	4,390			

Daily gage height, in feet, of Sacramento River at Jellys Ferry, California, for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	7.10	8.50	16.90	7.80	8.70	6.50	5.40	5.00	4.90	5.20	5.20	8.80
2	7.10	8.30	15.70	7.70	8.40	6.40	5.40	5.00	4.90	5.10	5.20	10.30
3	15.90	8.10	15.30	8.60	8.26	6.30	5.40	5.00	4.90	5.10	5.20	11.30
4	21.60	8.40	14.10	8.00	8.20	6.20	5.40	5.00	4.90	5.10	5.20	19.60
5	12.80	12.10	13.20	7.90	8.00	6.20	5.40	5.00	4.90	5.10	5.20	13.10
6	11.30	9.40	12.80	8.30	7.90	6.20	5.30	5.00	4.80	5.10	5.20	14.20
7	10.60	8.60	12.30	8.10	7.90	6.10	5.30	5.00	4.80	5.10	5.20	10.30
8	9.30	8.90	11.90	7.80	7.80	6.00	5.30	5.00	4.80	5.10	5.20	9.20
9	8.90	8.30	11.40	7.70	7.70	6.00	5.30	4.90	4.80	5.10	5.20	8.20
10	8.30	7.80	11.30	7.50	7.60	5.90	5.30	4.90	4.80	5.10	5.20	8.10
11	8.30	7.40	11.80	7.50	7.70	5.80	5.30	4.90	4.80	5.00	5.20	7.60
12	8.70	7.40	11.20	7.50	7.70	5.70	5.20	4.90	4.80	5.00	5.20	7.20
13	9.70	7.40	10.90	7.40	7.60	5.70	5.20	4.90	4.80	5.00	5.20	7.00
14	9.50	8.80	10.30	7.70	7.60	5.70	5.20	4.90	4.80	5.00	5.20	6.70
15	10.70	8.70	10.10	7.60	7.50	5.60	5.20	4.90	4.80	5.00	5.20	6.60
16	9.80	10.80	9.80	7.50	7.50	5.60	5.20	4.90	4.80	5.00	5.80	6.20
17	9.70	14.50	9.70	7.40	7.50	5.60	5.20	4.90	4.80	5.00	5.70	6.20
18	9.70	12.60	9.50	7.40	7.30	5.60	5.20	4.90	4.80	5.00	5.50	6.20
19	9.40	18.30	9.30	7.50	7.20	5.60	5.20	4.90	4.80	5.00	5.40	6.20
20	9.00	25.80	9.10	7.40	7.00	5.60	5.10	4.90	4.80	5.00	6.40	6.10
21	12.00	22.90	9.10	7.50	6.90	5.60	5.10	4.90	4.80	5.00	6.40	6.10
22	17.50	19.30	9.00	7.50	6.80	5.60	5.10	4.90	4.80	5.00	6.50	6.10
23	14.20	22.70	8.90	7.50	6.70	5.60	5.10	4.90	5.20	5.00	6.40	6.00
24	12.10	21.80	8.80	7.40	6.60	5.60	5.10	4.90	5.70	5.00	7.80	6.00
25	11.00	19.80	8.70	7.30	6.70	5.50	5.10	4.90	5.60	5.00	6.60	6.00
26	10.00	18.70	8.80	7.30	6.80	5.50	5.10	4.90	5.30	5.00	8.10	6.00
27	9.50	17.80	8.60	7.20	6.70	5.50	5.10	4.90	5.20	5.40	8.40	5.90
28	9.40	17.40	8.50	7.30	6.80	5.50	5.00	4.90	5.20	5.70	7.30	5.80
29	9.30	.....	8.40	9.70	6.80	5.50	5.00	4.90	5.10	5.70	16.50	5.80
30	9.00	.....	8.20	9.70	6.70	5.50	5.00	4.90	5.30	5.30	11.10	5.80
31	8.80	.....	8.20	.....	6.60	.....	5.00	4.90	.....	5.20	.....	5.70

STONY CREEK NEAR FRUTO, CAL.

This stream drains 700 square miles of the eastern slopes of the Coast Range. After reaching the Sacramento Valley it flows north for a number of miles, contrary to the general drainage, and then turns east and enters the Sacramento River below Vina, Cal. A large portion of the basin near the heads of the stream is heavily covered with commercial timber. There are a number of good reservoir sites on this stream and its tributaries.

On January 30, 1901, a gaging station was established by Mr. Burt Cole, at Julian's ranch, 6 miles northwest of the town of Fruto, Cal., to determine the amount of water available for storage.

The following meter measurements were made under the direction of J. B. Lippincott:

List of discharge measurements of Stony Creek near Fruto, Cal.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1900.	*Feet.*	*Sec.-ft.*	1901.	*Feet.*	*Sec.-ft.*
November 11	.....	62.0	March 9	5.6	933.3
1901.			April 10	4.9	382.0
February 27	6.9	2,583.0	September 3	3.17	3.4
February 19 [a]	14.0	18,000.0	November 21	4.3	165.0

[a] Estimated from float measurements.

Daily gage height, in feet, of Stony Creek near Fruto, Cal., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	5.90	6.70	5.00	5.20	4.40	3.10	3.30	3.20	4.70	3.70	4.80
2	.....	5.80	6.40	5.00	5.20	4.40	3.10	3.30	3.20	4.60	3.60	6.00
3	.....	5.70	6.20	5.10	5.10	4.30	3.10	3.30	3.20	4.60	3.60	5.30
4	.....	5.70	6.00	5.10	5.10	4.30	3.10	3.30	3.20	4.50	3.60	7.50
5	.....	5.90	5.90	5.00	5.10	4.30	3.00	3.20	3.20	4.50	3.60	6.00
6	.....	5.70	5.80	5.10	5.00	4.20	3.00	3.20	3.20	4.50	3.60	5.80
7	.....	5.60	5.70	5.00	4.90	4.20	3.00	3.20	3.20	4.40	3.60	5.00
8	.....	5.60	5.60	5.00	4.90	4.10	3.00	3.20	3.20	4.30	3.60	5.00
9	.....	5.50	5.60	4.90	4.90	4.00	2.90	3.20	3.20	4.20	3.60	4.90
10	.....	5.50	5.70	4.80	4.80	4.00	2.90	3.20	3.20	4.20	3.70	4.80
11	.....	5.40	5.80	4.80	4.80	3.90	2.80	3.20	3.20	4.10	3.70	4.80
12	.....	5.40	5.70	4.70	4.80	3.80	2.80	3.20	3.20	4.00	3.70	4.60
13	.....	5.80	5.60	4.70	4.80	3.80	2.80	3.20	3.20	3.90	3.70	4.50
14	.....	6.50	5.50	4.80	4.80	3.70	3.40	3.20	3.20	3.90	3.70	4.40
15	.....	6.00	5.50	4.90	4.80	3.70	3.40	3.20	3.30	3.80	3.90	4.30
16	.....	7.50	5.50	4.90	4.70	3.60	3.40	3.20	3.30	3.70	4.00	4.30
17	.....	7.00	5.50	4.80	4.70	3.60	3.40	3.20	3.30	3.60	3.80	4.20
18	.....	6.70	5.50	4.80	4.70	3.50	3.40	3.10	3.30	3.50	3.90	4.20
19	.....	10.50	5.40	4.70	4.60	3.50	3.40	3.10	3.30	3.40	3.90	4.20
20	.....	9.50	5.30	4.70	4.60	3.40	3.40	3.10	3.30	3.40	4.30	4.10
21	.....	8.30	5.30	4.70	4.70	3.40	3.40	3.10	3.30	3.30	4.30	4.10
22	.....	7.50	5.30	4.60	4.70	3.40	3.30	3.10	3.40	3.20	4.80	4.00
23	.....	8.70	5.20	4.60	4.70	3.30	3.30	3.10	3.40	3.20	4.80	3.90
24	.....	7.80	5.20	4.50	4.70	3.30	3.30	3.10	3.40	3.10	4.70	3.90
25	.....	7.30	5.20	4.50	4.80	3.30	3.30	3.10	3.50	3.00	4.50	4.00
26	.....	7.20	5.20	4.50	4.70	3.20	3.30	3.10	3.50	3.00	4.40	4.00
27	.....	7.00	5.20	4.50	4.70	3.20	3.30	3.10	3.50	4.60	4.40	4.10
28	.....	6.80	5.20	4.50	4.70	3.20	3.30	3.10	3.50	4.70	4.40	4.10
29	.....	.....	5.10	5.30	4.60	3.20	3.30	3.10	4.50	4.80	5.80	4.00
30	6.00	.....	5.10	5.20	4.60	3.20	3.30	3.10	5.40	4.80	5.30	4.00
31	6.00	.....	5.00	.....	4.50	.....	3.30	3.10	.....	3.80	.....	4.00

CACHE CREEK NEAR LOWER LAKE, CAL.

This stream is the outlet of Clear Lake, in Lake County, Cal., and is described in Water-Supply Paper No. 51, page 453.

On account of the great importance of Clear Lake as a storage reservoir, a gaging station was established at the wagon bridge across Cache Creek, one-half mile north of the town of Lower Lake, January 1, 1901.

The following meter measurements were made under the direction of J. B. Lippincott during 1901:

List of discharge measurements of Cache Creek near Lower Lake, Cal.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1901.	*Feet.*	*Sec.-ft.*	1901.	*Feet.*	*Sec.-ft.*
January 25	3.60	675	September 4	1.72	88.49
April 13	3.80	673	October 5	1.45	34.26
June 17	2.85	333	November 9	1.20	19.50
July 15	2.45	236	November 29	1.60	69.00
August 13	2.05	144	December 30	1.60	67.00

Daily gage height, in feet, of Cache Creek near Lower Lake, Cal., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.30	3.60	4.80	4.00	3.50	3.10	2.60	2.20	1.80	1.50	1.20	1.50
2	2.20	3.60	4.70	3.90	3.50	3.00	2.60	2.10	1.70	1.40	1.20	1.40
3	3.10	3.60	4.70	3.90	3.50	3.00	2.50	2.20	1.70	1.40	1.20	1.50
4	5.50	4.00	4.70	3.90	3.40	3.00	2.50	2.20	1.70	1.40	1.20	1.60
5	3.00	3.70	4.70	3.90	3.50	3.00	2.50	2.10	1.70	1.50	1.20	1.70
6	3.10	3.70	4.60	3.90	3.40	3.00	3.50	2.10	1.70	1.50	1.20	1.70
7	3.10	3.70	4.60	3.80	3.40	3.00	2.50	2.10	1.70	1.40	1.20	1.70
8	3.10	3.70	4.60	3.80	3.40	2.90	2.50	2.10	1.70	1.40	1.20	1.70
9	3.10	3.70	4.50	3.80	3.40	3.00	2.50	2.10	1.60	1.30	1.10	1.70
10	3.10	3.70	4.60	3.80	3.30	2.90	2.40	2.10	1.60	1.40	1.10	1.70
11	3.10	3.70	4.70	3.80	3.40	2.90	2.40	2.10	1.60	1.30	1.20	1.70
12	3.20	3.70	4.60	3.70	3.40	2.80	2.40	2.00	1.50	1.30	1.10	1.60
13	3.30	3.80	4.60	3.70	3.30	2.90	2.40	2.00	1.60	1.30	1.20	1.60
14	3.20	3.80	4.50	3.70	3.30	2.80	2.40	2.00	1.50	1.30	1.20	1.60
15	3.30	3.80	4.40	3.70	3.30	2.80	2.40	2.00	1.50	1.30	1.20	1.60
16	3.30	3.80	4.50	3.60	3.30	2.80	2.40	2.00	1.50	1.30	1.20	1.60
17	3.30	3.80	4.50	3.70	3.20	2.80	2.30	2.00	1.50	1.20	1.20	1.60
18	3.30	3.80	4.40	3.60	3.30	2.80	2.40	1.90	1.50	1.20	1.20	1.60
19	3.30	6.00	4.40	3.60	3.20	2.80	2.30	1.90	1.40	1.20	1.20	1.60
20	3.30	4.50	4.40	3.60	3.20	2.80	2.30	1.90	1.40	1.20	1.30	1.60
21	3.60	4.40	4.40	3.60	3.20	2.70	2.30	1.90	1.40	1.20	1.30	1.60
22	3.60	4.40	4.40	3.60	3.20	2.80	2.30	1.90	1.40	1.20	1.30	1.60
23	3.50	4.70	4.30	3.50	3.20	2.70	2.30	1.90	1.40	1.20	1.30	1.60
24	3.50	4.70	4.30	3.50	3.10	2.70	2.30	1.80	1.40	1.20	1.30	1.60
25	3.50	4.70	4.30	3.50	3.10	2.70	2.30	1.80	1.40	1.20	1.40	1.60
26	3.60	4.70	4.20	3.50	3.10	2.70	2.20	1.80	1.40	1.10	1.30	1.60
27	3.60	4.80	4.20	3.50	3.10	2.70	2.30	1.80	1.40	1.20	1.30	1.50
28	3.60	4.70	4.10	3.50	3.10	2.60	2.20	1.80	1.40	1.50	1.30	1.50
29	3.60	.....	4.10	3.40	3.10	2.70	2.20	1.80	1.50	1.30	1.60	1.50
30	3.60	.....	4.10	3.50	3.10	2.60	2.20	1.80	1.50	1.20	1.30	1.60
31	3.60	.....	4.00	.....	3.00	.....	2.20	1.80	.....	1.20	.....	1.60

MOKELUMNE RIVER AT ELECTRA, CAL.

The Mokelumne River drains 537 square miles of the western slopes of the Sierra Nevada, above Electra, Cal.

A gaging station was established at this point by Burr Bassell, while employed by the Standard Electric Company. Daily gage readings were taken from January 1 to June 30, 1901, and numerous meter measurements were made.

The following record is given by the courtesy of the Standard Electric Company. Measurements of discharge were made by B. Bassell as follows:

List of discharge measurements of Mokelumne River at Electra, Cal.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1901.	*Feet.*	*Sec.-ft.*	1901.	*Feet.*	*Sec.-ft.*
January 8	6.00	1,717	February 26	7.40	3,846
February 4	4.20	608	March 4	6.60	2,723
February 15	4.80	966	May 3	6.20	2,232
February 19	11.00	13,213	May 24	6.70	3,016
February 22	8.60	6,330			

Daily gage height, in feet, of Mokelumne River at Electra, Cal., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	Day.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	3.80	4.40	7.50	4.90	6.30	8.40	17	4.40	8.40	5.80	5.90	10.00	7.50
2	3.70	4.30	7.40	5.10	6.00	8.60	18	4.80	7.90	5.70	6.30	9.30	7.70
3	3.60	4.30	7.50	5.50	6.20	8.50	19	4.70	11.00	5.80	6.70	7.90	7.30
4	3.70	4.20	6.60	5.30	6.50	8.70	20	4.70	10.00	5.70	6.80	7.50	6.90
5	4.80	6.00	6.70	5.10	6.80	8.80	21	4.80	9.10	5.60	6.90	6.70	7.00
6	5.00	5.00	6.70	5.20	6.90	8.50	22	4.80	8.60	5.80	6.90	6.80	7.20
7	7.80	4.80	6.60	5.00	7.10	8.40	23	4.80	9.00	5.70	6.70	7.50	6.90
8	6.00	4.50	6.30	5.00	7.00	8.30	24	4.50	8.90	5.50	6.80	7.00	6.50
9	5.80	4.20	6.10	4.90	7.20	7.60	25	4.80	8.30	5.40	6.70	6.60	5.90
10	4.80	4.60	6.00	4.80	7.60	7.00	26	4.50	7.40	5.40	6.80	6.50	5.50
11	4.70	4.20	6.00	4.90	9.50	6.70	27	4.40	7.40	5.30	6.80	6.10	5.40
12	5.30	4.40	6.30	5.20	9.60	6.60	28	4.60	7.30	5.40	6.80	6.20	5.80
13	4.80	4.30	5.80	5.50	9.60	6.40	29	4.40	.....	5.30	6.90	6.30	7.00
14	5.00	4.20	5.70	5.90	9.70	6.30	30	4.40	.....	5.20	6.60	8.20	6.80
15	4.60	4.80	5.60	6.10	9.20	6.80	31	4.30	.....	5.10	.....	8.00	.....
16	4.70	4.90	5.60	6.20	9.30	7.60							

STANISLAUS RIVER NEAR OAKDALE, CAL.

This station was first established May 3, 1896, and was relocated on July 30, 1898. It is described in Water-Supply Paper No. 51, page 455. Results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 464.

The record at this station was discontinued February 16, 1901.

During the year the following meter measurements were made under the direction of J. B. Lippincott:

January 29: Gage height, 6.18 feet; discharge, 9.65 second-feet.
October 31: Gage height, 4.70 feet; discharge, 189 second-feet.

Daily gage height, in feet, of Stanislaus River near Oakdale, Cal., for 1901.

Day.	Jan.	Feb.	Day.	Jan.	Feb.	Day.	Jan.	Feb.
1	5.40	6.10	12	7.00	6.70	23	6.60	.....
2	5.30	6.00	13	7.40	6.70	24	6.40	.....
3	5.40	6.00	14	7.10	6.60	25	6.30	.....
4	5.50	6.10	15	6.90	6.50	26	6.40	.....
5	6.50	6.30	16	6.80	6.70	27	6.40	.....
6	10.50	9.10	17	6.90	.....	28	6.30	.....
7	15.00	7.70	18	6.60	.....	29	6.20	.....
8	10.00	7.60	19	6.50	.....	30	6.10	.....
9	8.00	7.50	20	6.50	.....	31	6.10	.....
10	7.50	6.90	21	6.40	.....			
11	7.10	6.70	22	6.80	.....			

TUOLUMNE RIVER AT HETCH HETCHY VALLEY DAM SITE, CALIFORNIA.

The entire drainage area of the Tuolumne River above Lagrange is about 1,500 square miles, about 400 square miles of which lie above the Hetch Hetchy dam site, which has an elevation of 3,630 feet above sea level. This upper drainage area consists of high granite mountains culminating in Mount Dana, Mount Gibbs, and Mount Lyell.

A gaging station was established at this point May 30, 1901, by J. B. Lippincott for the city of San Francisco, and the following

meter measurements and gage heights are given by the courtesy of Mr. C. E. Grunsky, city engineer of San Francisco, Cal.:

List of discharge measurements of Tuolumne River at Hetch Hetchy Valley dam site, California.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1901.	*Feet.*	*Sec.-ft.*	1901.	*Feet.*	*Sec.-ft.*
June 29	36	7,621	August 29	12.93	190
July 4	30	3,296	September 5	12.65	156
July 12	26.1	2,720	September 14	12.42	78
July 21	24.17	1,886	September 20	12.32	66
July 29	21.5	1,160	September 28	13.11	145
August 2	20.35	1,137	October 5	12.92	116
August 13	15.70	472	October 11	12.60	88
August 25	13.28	231			

Daily gage height of Tuolumne River at Hetch Hetchy Valley dam site, for 1901.

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Day.	May.	June.	July.	Aug.	Sept.	Oct.
1		22.50	30.00	20.62	12.81	13.04	17		30.00	24.50	14.92	12.39	
2		24.55	28.60	20.33	12.77	13.01	18		30.00	24.00	14.70	12.37	
3		24.00	25.80	19.87	12.73	12.92	19		32.00	24.00	14.45	12.35	
4		24.00	30.00	19.41	12.69	12.95	20		32.00	24.00	14.26	12.32	
5		24.00	30.00	18.94	12.65	12.92	21		32.00	24.20	14.04	12.41	
6		24.50	28.00	18.48	12.60	12.87	22		33.00	24.40	13.82	12.52	
7		24.50	28.00	18.02	12.56	12.81	23		30.00	24.00	13.60	12.64	
8		26.00	25.00	17.95	12.52	12.76	24		30.00	23.00	13.48	12.73	
9		26.00	25.00	17.49	12.48	12.70	25		30.00	23.00	13.28	12.82	
10		27.00	24.10	17.03	12.43	12.65	26		31.50	22.00	13.19	12.92	
11		28.00	26.00	16.57	12.43	12.60	27		30.40	22.00	13.10	13.01	
12		28.00	26.10	16.11	12.42	12.50	28		34.80	21.50	13.10	13.11	
13		29.00	26.60	15.70	12.42	12.56	29		36.00	21.50	12.93	13.08	
14		29.00	26.00	15.58	12.42	12.53	30	32.30	31.70	21.00	12.89	13.06	
15		30.00	24.50	15.36	12.41	12.50	31	32.00		21.00	12.85		
11		31.00	26.00	15.14	12.40								

ELEANOR CREEK AT ELEANOR TRAIL CROSSING, CAL.

Eleanor Creek is a tributary of Cherry River, and enters the stream 6 miles above its mouth. The elevation of the outlet of Lake Eleanor is 4,655 feet above sea level. The drainage area above the gaging station is 81 square miles, and consists of high granite mountains culminating in Richardson Peak, elevation 9,845 feet; Haystack Peak, elevation, 9,966 feet; and an unnamed peak, elevation, 10,510 feet. The average elevation of the drainage basin is probably 7,500 feet.

A gaging station was established by J. B. Lippincott, at the outlet of Lake Eleanor, June 1, 1901, for the city of San Francisco. The following meter measurements and gage heights are given by the courtesy of Mr. C. E. Grunsky, city engineer of San Francisco, Cal.:

List of discharge measurements of Eleanor Creek at Eleanor trail crossing, Cal.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1901.	*Feet.*	*Sec.-feet.*	1901.	*Feet.*	*Sec.-feet.*
June 10	8.67	411	August 23	6.47	32
June 22	9.77	793	August 27	6.26	18
July 8	8.57	310	August 30	6.05	14
July 16	7.92	263	September 6	5.90	6
July 18	7.8	225	September 14	5.70	4
July 27	7.45	145	September 21	5.72	5
August 3	7.1	84	September 26	5.85	6
August 10	6.92	75	October 3	6.40	34
August 17	6.48	30	October 10	6.21	21
August 19	6.68	42	October 14		15

Daily gage height, in feet, of Eleanor Creek at Eleanor trail crossing for 1901.

Day.	June.	July.	Aug.	Sept.	Oct.	Day.	June.	July.	Aug.	Sept.	Oct.
1	11.00	9.10	7.30	6.20	6.30	17	10.00	7.84	6.50	5.70	.....
2	11.08	9.00	7.20	6.10	6.40	18	10.00	7.80	6.60	5.70	.....
3	10.50	9.00	7.10	6.10	6.40	19	10.00	7.85	6.70	5.70	.....
4	10.20	9.00	7.10	6.00	6.40	20	9.80	7.85	6.60	5.70	.....
5	10.10	8.50	7.10	6.00	6.30	21	9.80	7.85	6.60	5.70	.....
6	10.00	8.50	7.00	5.90	6.30	22	9.77	7.70	6.50	5.80	.....
7	9.50	8.50	7.00	5.90	6.30	23	9.70	7.70	6.50	5.80	.....
8	9.00	8.57	6.90	5.90	6.25	24	9.70	7.60	6.40	5.80	.....
9	9.10	8.60	6.90	5.90	6.20	25	9.70	7.60	6.40	5.80	.....
10	8.67	8.60	6.92	5.90	6.20	26	9.70	7.50	6.30	5.85	.....
11	8.60	8.60	6.90	5.90	6.20	27	9.40	7.45	6.30	5.90	.....
12	8.60	8.60	6.80	5.90	6.20	28	9.00	7.45	6.30	6.00	.....
13	8.60	7.90	6.70	5.70	6.15	29	9.00	7.45	6.20	6.10	.....
14	10.00	7.90	6.60	5.70	6.10	30	9.50	7.40	6.20	6.20	.....
15	10.00	7.90	6.50	5.70	6.10	31	.....	7.40	6.20	.....	.....
16	10.00	7.92	6.50	5.70	.....						

CHERRY RIVER AT ELEANOR TRAIL CROSSING, CAL.

Cherry River is a tributary of the Tuolumne and enters that stream 12½ miles below Hetch Hetchy Valley. The area drained is 130 square miles.

A gaging station was established by J. B. Lippincott for the city of San Francisco at the point where Eleanor trail crosses the river, May 26, 1901. The following meter measurements and gage heights are given by the courtesy of Mr. C. E. Grunsky, city engineer of San Francisco, Cal.:

List of discharge measurements of Cherry River at Eleanor trail crossing, Cal.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1901.	*Feet.*	*Sec.-ft.*	1901.	*Feet.*	*Sec.-ft.*
July 8	11.4	915	September 7	7.7	6
July 17	10.4	510	September 17	7.0	4.3
August 9	8.75	112	September 22	7.06	4.50
August 19	9.1	132	September 26	9.05	141
August 20	8.4	107	October 3	8.96	120
August 24	8.1	43	October 10	8.0	43
September 1	7.8	17			

Daily gage height, in feet, of Cherry River at Eleanor trail crossing for 1901.

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Day.	May.	June.	July.	Aug.	Sept.	Oct.
1	.....	12.30	13.20	9.40	7.80	9.00	17	.....	11.50	10.40	9.00	7.00	.....
2	.....	12.60	13.00	9.30	7.80	9.00	18	.....	11.00	10.40	9.00	7.00	.....
3	.....	12.85	12.40	9.20	7.80	9.00	19	.....	12.00	10.35	9.10	7.00	.....
4	.....	12.00	12.40	9.10	7.70	8.80	20	.....	12.00	10.28	8.40	7.00	.....
5	.....	11.60	12.40	9.10	7.70	8.70	21	.....	12.40	10.20	8.40	7.10	.....
6	.....	11.20	12.40	9.00	7.70	8.40	22	.....	12.40	10.13	8.30	7.10	.....
7	.....	12.00	12.00	8.90	7.70	8.30	23	.....	12.30	10.05	8.20	7.50	.....
8	.....	12.70	11.40	8.80	7.70	8.30	24	.....	12.25	9.98	8.10	8.00	.....
9	.....	12.00	11.40	8.80	7.70	8.10	25	.....	12.50	9.90	8.10	8.50	.....
10	.....	11.65	11.00	8.80	7.60	8.10	26	12.20	12.50	9.83	8.10	9.10	.....
11	.....	11.50	11.00	8.80	7.50	8.10	27	12.20	12.50	9.75	8.00	9.00	.....
12	.....	11.50	10.00	8.80	7.40	8.00	28	12.20	13.00	9.68	8.00	9.00	.....
13	.....	11.25	10.00	8.90	7.30	8.00	29	12.10	13.50	9.60	7.90	9.00	.....
14	.....	11.50	10.00	8.90	7.20	7.80	30	12.20	14.00	9.53	7.90	9.00	.....
15	.....	11.70	10.00	8.90	7.10	7.90	31	12.30	.....	9.45	7.80	.....	.....
16	.....	11.70	10.00	8.90	7.00	.....							

TUOLUMNE RIVER AT LAGRANGE, CAL.

This station, established August 29, 1895, is at the wagon bridge in Lagrange, and is below the high dam of the Turlock and Modesto irrigation districts, and also below the head of the canal of the Lagrange Hydraulic Mining Company. It is described in Water-Supply Paper No. 51, page 456. Results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 465. The flow of the Hydraulic Mining Company's canal was 10 second-feet from January 1 to March 31, 1901, and 7 second-feet from April 1 to July 28, 1901. During 1901 the following measurements of discharge were made under direction of J. B. Lippincott:

List of discharge measurements of Tuolumne River at Lagrange, Cal.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1901.	*Feet.*	*Sec.-ft.*	1901.	*Feet.*	*Sec.-ft.*
January 29	5.75	1,419	August 2	5.45	1,354
April 7	6.10	2,382	August 31	4.30	248
June 12	7.63	6,470			

Daily gage height, in feet, of Tuolumne River at Lagrange, Cal., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	5.00	5.70	7.90	5.90	7.30	9.10	8.80	5.60	4.20	4.50	5.10	5.40
2	4.90	5.60	7.90	5.80	7.00	9.30	8.10	5.50	4.30	4.50	4.90	5.30
3	4.80	5.60	7.70	6.40	7.10	9.50	7.80	5.50	4.30	4.30	4.90	5.30
4	5.10	5.60	7.40	6.20	7.10	9.50	7.40	5.60	4.20	4.30	4.80	7.50
5	7.10	10.00	7.40	6.10	7.40	9.40	7.10	5.80	4.20	4.20	4.70	7.00
6	11.40	7.70	7.40	6.10	7.60	8.90	7.40	5.90	4.10	4.20	4.60	6.80
7	10.90	6.80	7.30	6.10	8.00	9.20	7.40	6.00	4.20	4.10	4.60	7.30
8	7.70	6.70	7.10	6.00	8.40	9.10	7.20	5.50	4.10	3.80	4.60	6.80
9	7.00	6.60	7.00	5.90	8.60	9.10	7.20	5.30	4.10	3.70	4.50	6.50
10	6.60	6.30	6.80	5.80	8.90	8.40	6.80	5.20	4.00	3.70	4.80	6.10
11	6.50	6.10	6.70	5.80	8.90	7.60	6.60	5.20	4.10	3.70	5.10	5.20
12	6.70	6.00	6.70	6.10	9.30	7.60	6.80	5.00	4.10	3.60	5.00	5.10
13	6.50	6.00	6.60	6.20	9.60	7.50	6.90	4.80	4.10	3.50	4.90	5.00
14	6.40	6.10	6.50	6.50	9.80	7.30	6.90	4.50	4.00	3.40	4.80	4.90
15	6.20	6.50	6.50	6.70	9.70	7.50	6.70	4.80	4.00	3.40	4.70	4.90
16	6.10	6.40	6.40	6.80	9.70	8.10	6.70	4.70	4.00	3.30	4.60	5.00
17	6.00	9.50	6.40	6.80	9.60	8.20	6.60	4.60	3.90	3.30	4.70	4.90
18	6.00	9.20	6.40	6.90	9.50	8.70	6.40	4.40	4.00	3.20	4.60	4.80
19	5.90	11.70	6.30	7.20	9.30	8.70	6.30	4.20	3.90	3.20	4.60	4.60
20	5.90	10.50	6.40	7.30	8.30	8.50	6.10	4.70	3.90	3.20	4.50	4.60
21	6.20	9.70	6.40	7.50	7.90	9.20	6.10	4.70	3.90	3.20	4.40	4.50
22	6.30	9.70	6.50	7.50	7.60	9.80	6.10	5.20	3.80	3.30	4.80	4.50
23	6.00	10.90	6.50	7.40	7.50	9.40	6.10	4.90	4.10	3.20	4.70	4.40
24	6.00	10.50	6.40	7.60	7.60	8.50	6.20	4.70	4.40	3.30	4.70	4.40
25	6.10	8.80	6.30	7.90	7.30	7.80	6.10	4.60	4.40	3.30	4.80	4.40
26	6.00	8.10	6.30	7.80	7.10	7.50	6.00	4.60	4.30	3.30	4.70	4.40
27	5.80	7.90	6.30	7.60	7.00	7.20	5.90	4.50	4.20	3.30	4.80	4.40
28	5.80	7.80	6.30	7.50	6.90	8.80	5.80	4.40	4.20	5.70	4.90	4.30
29	5.70	.....	6.10	7.60	7.30	9.30	5.70	4.30	4.30	5.40	5.40	4.40
30	5.70	.....	6.00	7.90	8.10	8.90	5.60	4.20	4.50	5.10	5.50	4.30
31	5.70	.....	6.00	.....	8.50	.....	5.60	4.20	.....	5.20	.....	4.20

LAGRANGE DITCH AND HYDRAULIC MINING COMPANY'S CANAL.

The flumes of this company are decaying and their carrying capacity is diminishing.

The flow in this canal from January 1 to March 31, 1901, averaged approximately 10 second-feet; from April 1 to July 28, approximately 7 second-feet, and from July 28 to the end of the year, approximately 5 second-feet.

TURLOCK CANAL.

The record on this canal is incomplete.

During the night of August 3, 1901, a break occurred in the flume one-half mile below the head gate. The water was out of the canal for one month while repairs were being made. No reliable record was obtainable after August 3, 1901.

Daily gage height, in feet, of Turlock Canal at Lagrange, Cal., for 1901.

Day.	Apr.	May.	June.	July.	Aug.	Day.	Apr.	May.	June.	July.	Aug.
1		2.30	2.30	2.90	3.00	17	2.25	2.30	2.90		
2		2.20	2.20	3.00	3.00	18	2.30	2.30	2.90		
3		2.30	2.00	3.00	3.00	19	2.30	2.30	2.90		
4		2.30	2.20	3.00		20	2.40	2.30	2.90		
5		2.20	2.20	3.00		21	2.45	2.30	2.90	3.00	
6		2.20	2.25	3.00		22	2.50	2.30	2.90	3.00	
7		2.20	2.25	3.00		23	2.40	2.30	2.90	3.00	
8		2.20	2.25	3.00		24	2.65	2.30		3.00	
9		2.20	2.80	3.00		25	2.65	2.30		3.00	
10	2.50	2.20	2.80	3.00		26	1.60	2.30		3.00	
11	2.30	2.20	2.80	3.00		27	2.10	2.25		3.00	
12	2.30	1.00	1.40	3.00		28	2.60	2.25	2.20	3.00	
13	2.10	2.20	2.60	3.00		29	2.70	2.25	2.90	3.00	
14	2.50	2.20	2.80			30	2.70	2.30		3.00	
15	2.50	2.30	2.80			31		2.30		3.00	
16	2.30	2.30	2.80								

MERCED RIVER ABOVE MERCED FALLS, CAL.

Merced River above Merced Falls drains approximately 1,090 square miles of the western slopes of the Sierra Nevada. There are included in the eastern portion of its drainage area a large number of high peaks, the highest, Mount Lyell, reaching an elevation of 13,042 feet.

The midsummer flow of this stream is much larger in proportion to its drainage area than that of the Tuolumne River, which joins it on the north.

The measurement of this stream was undertaken in response to numerous requests from mining and irrigation interests. The midsummer flow of the stream is less than the combined capacity of the irrigation and power canals taking water in the vicinity of Snelling. The owners of these canals offered to pay $100 toward the expenses of equipping and maintaining the gaging station for the first year. H. H. Henderson, county surveyor of Merced County, established a gaging station at a point 1 mile above Merced Falls, April 6, 1901. Meter measurements are made from a cable. The observer is Mr. Charles Siegfeldt.

The following meter measurements were made in 1901 under the direction of J. B. Lippincott:

List of discharge measurements of Merced River above Merced Falls, Cal.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1901.	*Feet.*	*Sec.-ft.*	1901.	*Feet.*	*Sec.-ft.*
April 6	10.30	1,379	August 2	10.05	1,123
June 1	12.00	4,139	August 31	8.60	220

Daily gage height, in feet, of Merced River above Merced Falls, Cal., for 1901.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	11.6	13.1	12.2	10.1	8.6	8.8	9.4	9.3
2	.....	11.4	13.4	12.0	10.0	8.6	8.9	9.3	9.2
3	.....	11.2	13.4	11.9	10.3	8.6	8.9	9.2	9.2
4	.....	11.3	13.6	11.4	10.4	8.5	8.8	9.1	10.5
5	.....	11.6	13.4	11.2	10.6	8.5	8.7	9.2	10.7
6	10.3	11.8	13.2	11.2	10.8	8.4	8.6	9.2	10.8
7	10.3	12.2	13.2	11.2	10.3	8.4	8.6	9.2	10.2
8	10.1	12.5	13.2	11.1	10.0	8.4	8.5	9.0	9.8
9	10.1	12.8	12.8	11.1	9.8	8.4	8.5	8.9	9.7
10	10.0	13.2	12.4	11.0	9.7	8.4	8.5	9.4	9.6
11	10.1	13.4	12.1	10.8	9.6	8.4	8.5	9.3	9.4
12	10.1	13.7	12.0	10.8	9.4	8.4	8.4	9.2	9.3
13	10.5	13.8	11.9	10.8	9.3	8.3	8.4	9.2	9.1
14	10.7	13.7	11.6	10.8	9.2	8.3	8.4	9.2	9.0
15	10.8	13.7	11.8	10.6	9.2	8.3	8.3	9.1	9.0
16	10.8	13.8	12.3	10.6	9.2	8.3	8.3	9.0	9.0
17	10.9	14.0	12.2	10.5	9.2	8.3	8.3	9.0	9.0
18	11.0	13.7	12.6	10.4	9.4	8.3	8.3	8.9	8.9
19	11.4	13.3	12.7	10.4	9.4	8.2	8.3	8.9	8.9
20	11.6	12.8	12.3	10.4	9.3	8.2	8.3	8.6	8.9
21	11.7	12.3	12.6	10.4	9.1	8.2	8.3	7.0	8.9
22	11.8	12.1	13.0	10.4	9.0	8.3	8.3	8.9	8.9
23	11.8	12.1	12.6	10.5	8.9	8.4	8.3	8.9	8.8
24	11.8	12.0	12.3	10.5	8.9	8.6	8.3	8.9	8.8
25	12.2	11.8	11.9	10.4	8.8	8.7	8.3	8.8	8.8
26	11.9	11.6	11.7	10.3	8.8	8.7	8.4	8.8	8.8
27	11.9	11.5	11.6	10.2	8.6	8.7	8.9	8.8	8.8
28	11.9	11.5	11.9	10.2	8.6	8.6	9.9	9.3	8.8
29	11.6	11.6	12.4	10.0	8.6	8.6	9.7	9.3	8.8
30	12.4	11.9	12.3	10.1	8.6	8.6	9.4	9.6	8.7
31	.....	12.6	.....	10.0	8.6	.....	9.3	.....	8.6

SAN JOAQUIN RIVER AT HERNDON, CAL.

This station, established by the Southern Pacific Company in 1879, is at the iron highway bridge crossing the river at Herndon. It is described in Water-Supply Paper No. 51, page 458.

A reconnaissance has been made of the river above Polasky, with the view of locating a new station where the section will be more permanent, but no place entirely satisfactory has been found.

Results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 466.

During 1901 the following measurements of discharge were made under the direction of J. B. Lippincott:

List of discharge measurements of San Joaquin River at Herndon, Cal.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1901.	*Feet.*	*Sec.-ft.*	1901.	*Feet.*	*Sec.-ft.*
January 30	4.00	1,357	July 31	5.67	3,909
March 2	6.80	6,179	October 16	2.25	352
April 3	5.00	3,357	October 16	.....	[a] 315

[a] At Polasky Ford.

Daily gage height, in feet, of San Joaquin River at Herndon, Cal., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.30	4.00	6.70	4.70	7.60	7.70	9.60	5.50	2.80	2.30	3.10	4.10
2	3.30	4.00	6.90	4.50	7.30	9.30	9.70	5.90	2.80	2.60	3.10	3.90
3	3.20	4.00	6.80	4.80	6.90	10.10	8.60	6.10	2.70	2.50	3.00	3.70
4	3.20	4.00	6.80	5.10	7.10	10.10	7.80	5.70	2.70	2.50	3.00	3.70
5	5.50	4.00	6.60	4.80	6.80	10.10	7.60	6.50	2.70	2.50	3.00	3.50
6	11.00	6.60	6.30	4.70	7.10	10.10	7.30	6.00	2.60	2.50	2.80	4.00
7	12.30	5.20	6.40	4.70	7.10	10.20	7.40	5.90	2.60	2.40	2.80	4.40
8	7.70	5.10	6.40	4.50	8.10	9.80	7.10	5.60	2.50	2.30	2.80	4.00
9	6.40	5.30	6.50	4.40	8.40	9.70	7.20	5.30	2.50	2.30	2.80	3.70
10	5.70	4.90	5.60	4.30	8.90	8.80	7.10	5.30	2.50	2.30	2.90	3.70
11	5.30	4.60	5.50	4.30	9.70	8.30	7.10	4.80	2.50	2.30	3.00	3.50
12	5.00	4.30	5.50	4.30	10.00	8.10	7.00	4.50	2.50	2.30	3.20	3.50
13	4.90	4.20	5.50	4.30	10.30	7.80	6.90	4.30	2.50	2.30	3.20	3.50
14	4.80	4.30	5.30	4.30	10.20	7.40	6.70	4.30	2.50	2.30	3.30	3.30
15	4.60	4.30	5.30	5.60	10.10	7.30	6.60	4.20	2.40	2.30	3.40	3.30
16	4.40	4.30	5.30	5.50	10.40	7.80	6.60	4.20	2.40	2.30	3.40	3.00
17	4.30	4.50	5.30	5.70	10.70	8.30	6.40	4.00	2.40	2.30	3.30	3.00
18	4.30	8.10	5.30	5.70	11.00	8.80	6.30	4.20	2.40	2.20	3.30	3.00
19	4.30	7.40	5.20	6.20	10.40	9.20	6.40	4.50	2.40	2.20	3.30	3.00
20	4.30	9.20	5.20	6.70	9.40	9.00	6.10	4.30	2.40	2.20	3.20	3.00
21	4.10	7.80	5.30	6.90	8.70	9.30	6.10	4.20	2.40	2.20	3.20	2.90
22	5.00	8.50	5.30	6.80	8.60	9.80	6.10	3.80	2.30	2.20	3.00	2.90
23	4.50	7.60	5.40	7.10	8.10	9.70	6.40	3.70	2.30	2.30	3.00	2.80
24	4.20	8.60	5.30	7.30	8.00	8.90	6.60	3.70	2.30	2.30	3.00	2.80
25	4.00	7.50	5.30	7.40	7.90	8.30	6.20	3.50	2.30	2.30	3.00	2.70
26	4.20	7.00	5.40	7.50	7.80	7.60	6.00	3.30	2.30	2.30	3.00	2.70
27	4.00	6.70	5.40	7.50	7.50	7.40	5.50	3.10	2.30	2.30	3.20	2.70
28	4.00	6.50	5.20	7.40	7.20	8.10	5.10	3.00	2.30	4.70	3.20	2.70
29	4.00	.....	5.00	6.90	6.90	8.60	5.10	3.00	2.30	3.70	3.30	2.70
30	4.00	.....	4.70	9.00	6.00	9.70	5.70	2.80	2.30	3.30	4.00	2.70
31	4.00	.....	4.70	.....	7.30	.....	5.80	2.80	.....	3.30	.....	2.70

KING RIVER NEAR RED MOUNTAIN, CALIFORNIA.

The gaging station, established September 3, 1895, is southwest of Red Mountain, and is 15 miles east of Sanger, at the mouth of the canyon of the river and above all diversions. It is described in Water-Supply Paper No. 51, page 459. Results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 467. During 1901 the following measurements of discharge were made under the direction of J. B. Lippincott:

List of discharge measurements of King River near Red Mountain, California.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1901.	*Feet.*	*Sec.-ft.*	1901.	*Feet.*	*Sec.-ft.*
January 31	5.40	991	May 21	10.50	10,869
February 28	7.90	3,593	July 30	7.54	3,179
April 14	6.48	1,915	October 17	4.10	301

Daily gage height, in feet, of King River near Red Mountain, California, for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4.60	5.70	8.20	6.50	9.00	11.40	11.00	7.70	5.00	4.40	4.90	5.30
2	4.50	5.40	8.30	6.60	8.80	11.80	10.70	7.90	4.90	4.40	4.80	4.90
3	4.60	5.40	8.20	6.80	8.80	12.00	10.30	7.70	4.80	4.30	4.80	4.90
4	4.60	7.80	8.10	6.50	8.90	12.30	9.60	9.00	4.70	4.40	4.90	4.90
5	11.00	8.40	8.00	6.45	9.20	12.20	9.80	9.00	4.70	4.30	4.90	5.60
6	12.00	7.30	8.10	6.45	9.50	12.30	10.30	9.10	4.70	4.30	5.00	5.60
7	15.80	7.00	8.10	6.40	10.00	12.20	10.20	8.00	4.70	4.30	4.90	5.60
8	11.10	6.80	7.90	6.30	10.30	12.10	10.00	7.60	4.60	4.20	4.80	5.30
9	9.40	6.50	7.70	6.20	10.80	11.50	9.70	7.30	4.60	4.20	4.70	5.20
10	[a]7.10	6.30	7.45	6.20	11.20	11.00	9.50	7.20	4.50	4.20	5.00	5.10
11	7.00	6.20	7.30	6.30	11.70	10.40	9.40	6.80	4.50	4.20	4.80	5.00
12	6.90	6.10	7.25	6.60	11.80	10.10	9.30	6.60	4.45	4.20	5.00	4.90
13	6.70	6.00	7.10	7.00	11.50	9.80	9.40	6.40	4.40	4.20	5.05	4.60
14	6.60	6.10	7.00	7.50	11.40	9.50	8.90	6.20	4.30	4.10	5.00	4.70
15	6.50	6.20	6.85	7.60	11.60	9.40	8.70	6.10	4.40	4.10	4.40	4.70
16	6.00	6.20	6.90	7.80	11.80	10.30	8.50	6.70	4.30	4.10	4.80	4.60
17	5.70	6.30	7.00	8.00	12.30	11.00	8.70	6.40	4.30	4.10	4.70	4.70
18	5.70	9.20	7.00	8.40	12.40	11.10	8.70	6.80	4.30	4.10	4.60	4.60
19	5.70	9.10	7.20	8.80	11.50	10.90	8.50	6.60	4.30	4.10	4.60	4.50
20	5.70	9.00	7.20	9.10	11.20	11.10	8.40	6.10	4.30	4.10	4.50	4.50
21	5.50	8.50	7.30	9.30	10.50	11.40	8.50	5.90	4.30	4.10	4.50	4.50
22	6.00	9.40	7.30	9.40	10.10	11.80	8.20	5.70	4.30	4.10	4.70	4.40
23	6.20	8.50	7.20	9.50	10.00	11.70	8.50	5.50	4.30	4.10	4.70	4.45
24	6.20	9.20	7.10	9.80	9.90	10.80	8.30	5.30	4.60	4.10	4.60	4.45
25	6.20	8.40	7.00	10.00	9.60	10.60	8.00	5.20	4.60	4.20	4.50	4.35
26	6.20	8.20	7.10	9.70	9.20	9.90	8.00	5.10	4.60	4.20	4.50	4.35
27	6.00	8.00	6.90	9.80	9.10	10.40	7.80	5.00	4.50	6.60	4.40	4.30
28	5.80	8.00	6.70	9.70	9.00	10.80	8.00	5.00	4.50	6.00	4.40	4.30
29	5.60	.....	6.60	9.10	9.10	11.60	7.70	5.00	4.40	5.40	5.60	4.30
30	5.40	.....	6.60	10.50	9.40	11.80	7.60	5.00	4.40	5.30	6.00	4.30
31	5.40	.....	6.60	.....	10.30	.....	7.80	4.90	.....	5.00	.....	4.30

[a] Gage heights from January 10 to 30, inclusive, and February 2 and 3 are estimated from rainfall and comparison with San Joaquin River.

KING RIVER NEAR KINGSBURG, CAL.

The Southern Pacific Company has maintained gage readings at the railroad bridge 1 mile south of Kingsburg since 1879, and it is through its courtesy that the following record of gage heights for 1900 has been furnished to the Survey. Gage heights for 1900 will be found in Water-Supply Paper No. 51, page 461. No measurements of discharge were made here during 1901.

Daily gage height, in feet, of King River near Kingsburg, Cal., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4.2	6.3	8.0	5.3	8.9	10.3	10.5	4.2	2.9	3.3	4.5	5.3
2	4.1	6.2	8.1	5.0	8.4	11.1	10.3	4.4	2.8	3.3	4.5	5.3
3	4.0	6.1	8.3	5.2	7.9	11.5	9.0	4.3	2.7	3.3	4.4	5.2
4	4.4	6.2	8.1	5.3	7.8	11.8	8.3	4.8	2.7	3.3	4.3	5.2
5	9.0	6.3	7.9	4.7	8.1	11.7	8.0	7.0	2.7	3.2	4.3	5.5
6	10.3	8.0	7.9	4.7	8.3	11.7	8.0	7.0	2.7	3.0	4.4	5.6
7	14.7	7.7	7.9	5.4	8.7	11.6	7.9	5.5	2.7	2.7	4.4	6.0
8	9.5	7.3	7.8	5.5	9.2	11.4	7.8	4.7	2.9	2.7	4.3	5.4
9	8.3	7.6	7.7	5.4	10.0	10.9	7.5	4.3	3.0	2.7	4.3	5.3
10	7.8	7.3	7.5	5.4	10.5	10.0	6.7	3.8	2.9	2.7	4.3	5.3
11	7.5	7.2	7.3	5.3	11.2	9.2	6.3	3.7	2.9	2.8	4.6	5.3
12	7.3	7.0	7.3	5.3	11.5	8.8	6.2	3.3	2.9	2.8	4.6	4.8
13	7.1	6.9	7.2	5.2	11.4	8.4	6.1	3.0	2.9	2.8	4.6	4.6
14	6.8	6.8	7.0	5.3	11.0	7.7	5.7	2.7	2.9	2.7	4.6	4.3
15	6.7	6.7	6.8	6.1	11.0	7.5	5.5	2.6	2.9	2.7	4.5	4.3
16	6.7	6.9	6.8	5.9	11.5	8.7	5.3	3.1	2.9	2.7	4.5	4.4
17	6.5	7.0	6.7	6.2	12.0	9.5	5.2	3.1	2.9	2.8	4.4	4.3
18	6.3	8.7	6.7	6.3	12.1	9.9	5.2	3.4	2.9	2.7	4.3	4.3
19	6.3	8.7	6.7	7.0	11.5	9.8	5.1	3.7	2.8	2.7	4.3	4.3
20	6.3	8.7	6.7	7.4	10.7	9.7	4.8	3.7	2.8	2.8	4.3	4.3
21	6.3	8.6	6.7	8.2	9.7	10.2	4.8	3.3	3.1	2.8	4.3	4.3
22	6.7	9.7	6.7	8.3	9.0	10.8	4.8	3.1	3.2	2.8	4.3	4.2
23	6.3	8.6	6.6	8.5	9.0	10.7	5.1	3.0	3.2	2.8	4.3	4.1
24	6.3	9.3	6.6	8.7	8.5	9.8	5.0	2.9	3.3	2.8	4.2	4.1
25	6.2	8.6	6.2	9.0	8.0	9.3	4.7	3.0	3.4	2.8	4.1	4.1
26	6.2	8.2	6.3	8.6	8.0	8.5	4.5	3.0	3.4	3.0	4.0	4.1
27	6.0	8.0	6.3	8.3	7.7	8.3	4.3	2.9	3.4	3.1	4.1	3.8
28	5.9	7.9	5.8	8.4	7.5	9.3	4.3	2.9	3.4	6.1	4.1	3.7
29	6.1	.....	5.5	7.9	7.4	10.2	4.3	2.9	3.3	5.0	4.3	3.7
30	6.0	.....	5.5	10.3	7.7	10.8	4.1	3.0	3.3	4.7	6.3	3.7
31	6.0	.....	5.5	.....	9.0	.....	4.0	2.9	.....	4.6	.....	3.7

SOUTHERN CALIFORNIA DRAINAGE.

NACIMIENTO CREEK NEAR BRYSON, CAL.

This stream drains the eastern slopes of the Santa Lucia Mountains and enters Salinas River above Bradley, Cal.

A gaging station was established by S. G. Bennett on this stream at Harris ranch, near Bryson post-office, Cal., February 17, 1901. The station was discontinued April 30, 1901, as no satisfactory reservoir sites had been found on this stream and the records ceased to be of value.

The total area drained above the gaging station is 171 square miles.

List of discharge measurements of Nacimiento Creek near Bryson, Cal.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1901.	*Feet.*	*Sec.-ft.*	1901.	*Feet.*	*Sec.-ft.*
February 17	6.15	284	April 3	5.30	121
March 18	5.50	144	June 3	4.82	33
March 25	5.30	105			

Daily gage height, in feet, of Nacimiento Creek near Bryson, Cal., for 1901.

Day.	Feb.	Mar.	Apr.	May.	Day.	Feb.	Mar.	Apr.	May.
1		6.30	5.20	7.60	17	6.10	5.50	5.00	
2		6.20	5.20		18	6.10	5.50	5.00	
3		6.10	5.20		19	6.20	5.50	5.00	
4		6.00	5.10		20	11.00	5.40	4.90	
5		5.90	5.10		21	8.70	5.40	4.90	
6		5.90	5.10		22	7.80	5.40	4.90	
7		5.80	5.10		23	7.50	5.30	4.90	
8		5.70	5.10		24	7.10	5.30	4.90	
9		5.70	5.10		25	6.90	5.30	4.90	
10		6.00	5.00		26	6.70	5.30	4.90	
11		6.30	5.00		27	6.60	5.20	4.90	
12		5.90	5.00		28	6.40	5.20	4.90	
13		5.80	5.00		29		5.20	7.00	
14		5.70	5.00		30		5.20	7.10	
15		5.60	5.00		31		5.20		
16		5.60	5.00						

SAN ANTONIO CREEK NEAR JOLON, CAL.

This stream drains the eastern slopes of the Santa Lucia Mountains and enters the Salinas River at Bradley, Cal.

A gaging station was established by W. W. Cockins, jr., near Jolon, Cal., December 15, 1900. The total area drained is 161 square miles.

The station was discontinued April 30, 1901, as no satisfactory reservoir sites had been found on this stream.

List of discharge measurements of San Antonio Creek near Jolon, Cal.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1901.	*Feet.*	*Sec.-ft.*	1901.	*Feet.*	*Sec.-ft.*
January 19	4.45	185	March 26	4.30	76
February 12	4.80	242	April 5	4.30	76
March 18	4.50	148	April 18	4.10	59

Daily gage height, in feet, of San Antonio Creek near Jolon, Cal., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	Day.	Jan.	Feb.	Mar.	Apr.
1	3.40	4.40	5.00	4.20	17	4.30	4.70	4.50	4.10
2	3.40	4.40	5.00	4.20	18	4.30	4.70	4.50	4.10
3	3.30	4.40	4.90	4.20	19	4.30	4.90	4.50	4.10
4	7.20	4.60	4.90	4.20	20	4.50	5.60	4.40	4.00
5	2.40	5.80	4.80	4.20	21	4.90	5.80	4.40	4.00
6	7.60	6.40	4.80	4.20	22	5.40	5.50	4.40	4.00
7	6.60	5.80	4.70	4.20	23	5.00	5.40	4.30	4.00
8	4.40	5.40	4.60	4.20	24	4.80	5.20	4.30	4.00
9	4.30	5.30	4.60	4.20	25	4.60	5.00	4.30	4.00
10	4.20	5.20	4.60	4.20	26	4.60	5.10	4.30	4.00
11	4.20	5.00	4.60	4.20	27	4.50	5.10	4.30	4.00
12	4.30	4.90	4.60	4.20	28	4.50	5.10	4.30	4.30
13	4.30	4.90	4.60	4.10	29	4.50	.....	4.30	4.70
14	4.30	4.80	4.50	4.10	30	4.50	.....	4.30	5.50
15	4.30	4.80	4.50	4.10	31	4.40	.....	4.30	.....
16	4.30	4.70	4.50	4.10					

SAN LORENZO CREEK NEAR KING CITY, CAL.

This stream drains the western slopes of the Gavilan Mountains and enters the Salinas River near King City, Cal. There is a reservoir and dam site on the stream 5 miles above its mouth. This stream is entirely dry during the summer months. The flood waters are used for winter irrigation. A gaging station was established by W. W. Cockins, jr., December 16, 1900, at Hollenbeck's ranch, a quarter of a mile below the dam site. The area of the watershed drained is 235 square miles.

List of discharge measurements of San Lorenzo Creek near King City, Cal.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1901.	*Feet.*	*Sec.-ft.*	1901.	*Feet.*	*Sec.-ft.*
January 22 [a]	4.98	•29	March 27 [b]	4.30	13
February 14	5.30	71	April 1 [b]	4.20	5
March 20	4.10	21			

[a] 5 miles above King City.

[b] Hollenbeck station.

Daily gage height, in feet, of San Lorenzo Creek near King City, Cal., for 1900 and 1901.

Day.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	Nov.	Dec.
1	.....	4.25	4.25	4.70	4.20	5.15	.....	1.20
2	.....	4.25	4.25	4.60	4.20	.....	.....	1.00
3	.....	4.25	4.25	4.60	4.35	.....	.....	1.00
4	.....	4.30	4.25	4.60	4.35	.....	.....	1.00
5	.....	7.80	12.00	4.60	4.40	.....	.....	1.00
6	.....	9.40	9.50	4.60	4.35	.....	.....	1.20
7	.....	7.05	8.50	4.60	4.20	.....	.....	1.10
8	.....	5.35	5.50	4.55	4.20	.....	.....	1.00
9	.....	4.85	5.50	4.50	4.20	.....	.....	1.00
10	.....	4.40	4.90	4.60	4.20	.....	1.30	1.05
11	.....	4.40	4.70	4.60	4.20	.....	1.30	1.05
12	.....	4.40	4.60	4.60	4.20	.....	1.30	1.05
13	.....	4.40	5.00	4.60	4.20	.....	1.30	1.05
14	.....	4.40	5.40	4.60	4.20	.....	1.00	1.05
15	.....	4.45	5.50	4.55	4.20	.....	1.00	1.05
16	4.30	4.45	5.40	4.45	4.20	.....	1.00	1.05
17	4.25	4.45	5.30	4.50	4.20	.....	1.00	1.05
18	4.35	4.45	5.60	4.45	4.20	.....	1.00	.95
19	4.35	4.50	5.70	4.45	4.20	.....	1.00	.95
20	4.25	4.50	5.90	4.45	4.20	.....	1.00	.95
21	4.25	4.70	6.05	4.45	4.20	.....	1.00	.95
22	4.25	4.80	5.25	4.45	4.20	.....	1.00	.90
23	4.25	4.60	5.15	4.45	4.20	.....	1.00	.90
24	4.25	4.40	5.15	4.45	4.20	.....	1.00	.90
25	4.25	4.30	5.10	4.45	4.20	.....	1.00	.90
26	4.25	4.30	5.00	4.30	4.25	.....	1.00	.90
27	4.25	4.35	5.00	4.25	4.30	.....	1.00	.90
28	4.25	4.40	4.90	4.25	4.30	.....	1.20	.90
29	4.25	4.25	.....	4.25	4.30	.....	2.75	.....
30	4.25	4.25	.....	4.25	4.65	.....	1.55	.....
31	4.25	4.25	.....	4.30	.....	.....	.....	.....

ARROYO SECO NEAR PINEY, CAL.

This stream rises on the eastern slope of the Santa Lucia Mountains, and flows east and empties into Salinas River at Soledad, Cal. A gaging station was established by W. W. Cockins, jr., December, 1900, at Foster's ranch, near Piney post-office, Cal. The high water of January, 1901, enlarged an old channel, and the gaging station was removed to Pettitt's ranch, 4 miles below. The purpose of establishing these gaging stations was to get the maximum flood discharge and the amount of water available for storage. The total area of watershed drained above Pettitt's ranch is 215 square miles.

List of discharge measurements of Arroyo Seco near Piney, Cal.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1901.	*Feet.*	*Sec.-ft.*	1901.	*Feet.*	*Sec.-ft.*
February 11	3.70	505	November 6[a]	5.20	15
July 10[a]	5.30	23			

[a] At Pettitt's ranch.

Daily gage height, in feet, of Arroyo Seco near Piney, Cal., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	Day.	Jan.	Feb.	Mar.	Apr.
1	3.00	3.20	3.80	3.00	17	3.50	3.60	3.30	2.80
2	3.00	3.20	3.80	3.00	18	3.40	3.60	3.30	2.80
3	3.00	3.20	3.70	3.00	19	3.30	4.50	3.20	2.80
4	6.30	3.30	3.70	3.00	20	3.40	5.50	3.10	2.80
5	6.10	5.80	3.60	3.00	21	4.20	5.00	3.10	2.80
6	7.00	5.40	3.60	3.00	22	3.80	4.70	3.10	2.80
7	6.00	3.80	3.50	3.00	23	3.70	4.70	3.10	2.80
8	5.00	3.50	3.60	2.90	24	3.60	4.50	3.10	2.80
9	4.50	4.00	3.50	2.90	25	3.50	4.30	3.10	2.80
10	4.20	4.00	3.40	2.90	26	3.50	4.10	3.10	2.80
11	4.00	3.60	3.40	2.80	27	3.50	4.00	3.00	2.80
12	3.90	3.70	3.40	2.90	28	3.40	4.00	3.00	2.80
13	3.80	3.70	3.40	2.80	29	3.30	.....	3.00	3.80
14	3.60	3.60	3.40	2.80	30	3.20	.....	3.00	5.50
15	3.60	3.60	3.30	2.80	31	3.20	.....	3.00	.....
16	3.50	3.60	3.30	2.80					

SALINAS RIVER NEAR SALINAS, CAL.

Salinas River is described in Water-Supply Paper No. 51, page 454. On account of the continual shifting of the stream bed, and the improbability of its water being used for either power or irrigation purposes, the record on this stream was discontinued on August 3, 1901.

List of discharge measurements of Salinas River near Salinas, Cal.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1901.	*Feet.*	*Sec.-ft.*	1901.	*Feet.*	*Sec.-ft.*
January 15	6.80	2,142	March 24	5.20	668
January 22	5.80	1,338	March 30	4.90	541
January 24	5.90	1,598	April 6	4.75	513
February 9	7.90	4,982	April 12	4.70	343
February 19	6.05	1,560	July 9	3.60	40
March 17	5.60	1,194	October 1[a]	.....	24

[a] Bed of stream has shifted and left gage rod to north.

Daily gage height, in feet, of Salinas River near Salinas, Cal., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.
1	4.65	4.95	6.25	4.65	4.95	4.15	3.50	3.45
2	4.60	4.90	6.05	4.65	5.70	4.15	3.50	3.45
3	4.60	4.90	6.05	4.65	6.35	4.10	3.50	3.45
4	4.60	4.90	6.00	4.65	6.45	3.95	3.50	
5	7.55	5.05	6.00	4.60	6.00	3.95	3.50	
6	16.15	12.25	5.95	4.55	5.65	3.80	3.50	
7	14.15	9.25	5.95	4.50	5.35	3.75	3.50	
8	11.25	8.45	5.95	4.50	5.15	3.75	3.50	
9	10.50	7.80	5.90	4.50	4.95	3.70	3.50	
10	9.75	7.65	5.90	4.45	4.90	3.70	3.50	
11	8.95	7.40	5.90	4.40	4.75	3.65	3.50	
12	8.55	7.10	5.85	4.40	4.70	3.60	3.50	
13	7.80	6.90	5.85	4.40	4.60	3.60	3.50	
14	7.30	6.65	5.80	4.40	4.50	3.60	3.50	
15	6.95	6.45	5.80	4.40	4.55	3.60	3.45	
16	6.50	6.25	5.70	4.40	4.55	3.60	3.45	
17	6.20	6.15	5.60	4.35	4.45	3.60	3.45	
18	6.00	6.05	5.45	4.35	4.45	3.60	3.45	
19	5.90	6.05	5.40	4.30	4.40	3.60	3.45	
20	5.80	6.90	5.35	4.30	4.30	3.60	3.45	
21	5.65	11.60	5.30	4.30	4.30	3.55	3.45	
22	5.80	9.15	5.20	4.30	4.30	3.55	3.45	
23	6.20	7.85	5.10	4.25	4.25	3.55	3.45	
24	6.25	7.55	5.00	4.20	4.25	3.55	3.45	
25	6.05	7.25	5.00	4.20	4.20	3.55	3.45	
26	5.85	7.00	4.95	4.20	4.20	3.55	3.45	
27	5.70	6.75	4.90	4.15	4.20	3.50	3.45	
28	5.55	6.50	4.85	4.15	4.20	3.50	3.45	
29	5.40		4.80	4.15	4.20	3.50	3.45	
30	5.25		4.75	4.15	4.20	3.50	3.45	
31	5.25		4.70		4.15		3.45	

TULE RIVER NEAR PORTERSVILLE, CAL.

The Tule River drains a portion of the western slope of the Sierra Nevada. Its watershed has somewhat less run-off than that of the Kaweah River, which joins it on the north, and is much less elevated and snow covered than the King River Basin. The water of this stream is all appropriated during the irrigation season, and a portion is used in irrigating valuable orange lands in the vicinity of Portersville, Cal.

The gaging station is located about 8 miles east of Portersville at a point just below the wagon bridge near the McFarland ranch, and about 1 mile above the mouth of the South Fork of Tule River. The station was established April 18, 1901. The gage rod is situated on the right bank of the river, 100 feet below the bridge. The 0 of the gage is 8 feet below a spike driven into a large cottonwood tree. The area of the watershed above the gaging station is approximately 300 square miles. Measurements of discharge were made by J. B. Lippincott and S. G. Bennett during 1901, as follows:

List of discharge measurements of Tule River near Portersville, Cal.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1901.	*Feet.*	*Sec.-ft.*	1901.	*Feet.*	*Sec.-ft.*
April 18	2.50	233	July 29	1.23	30
May 22	2.85	338	October 18	1.00	18
June 16	2.65	311	December 5	1.44	58

Daily gage height, in feet, of Tule River near Portersville, Cal., for 1901.

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.10	3.10	1.90	1.20	1.00	1.05	1.35	1.45
2	3.10	3.10	1.85	1.00	1.00	1.05	1.35	1.45
3	3.00	2.95	1.80	1.00	1.00	1.05	1.30	1.45
4	2.90	2.85	1.80	1.10	1.00	1.10	1.30	1.40
5	2.90	2.90	1.70	1.10	1.00	1.10	1.30	1.40
6	3.00	2.80	1.60	1.05	1.00	1.10	1.30	1.40
7	3.10	2.70	1.55	1.05	1.00	1.05	1.30	1.45
8	3.10	2.90	1.55	1.05	1.00	1.05	1.25	1.45
9	3.10	2.80	1.55	1.00	.95	1.00	1.25	1.50
10	3.40	2.60	1.50	1.00	.95	1.00	1.30	1.50
11	3.20	2.45	1.50	1.00	.90	1.00	1.40	1.50
12	3.30	2.50	1.50	1.00	.90	1.05	1.40	1.45
13	3.30	2.50	1.45	1.00	.80	1.05	1.35	1.40
14	3.20	2.40	1.45	1.00	.75	1.05	1.35	1.40
15	3.20	2.30	1.40	1.00	.75	1.05	1.35	1.40
16	3.20	2.20	1.40	1.00	.75	1.00	1.35	1.40
17	3.25	2.25	1.40	1.00	.80	1.00	1.30	1.40
18	3.20	2.35	1.40	1.00	.85	1.00	1.30	1.40
19	3.15	2.30	1.40	1.00	.95	1.00	1.30	1.40
20	3.10	2.25	1.40	1.00	.95	1.05	1.30	1.40
21	3.00	2.20	1.35	1.00	.95	1.05	1.30	1.35
22	2.85	2.20	1.35	1.00	.95	1.05	1.30	1.35
23	2.80	2.20	1.35	1.00	.95	1.00	1.30	1.35
24	2.70	2.15	1.35	1.00	1.00	1.00	1.30	1.30
25	3.90	2.10	1.35	1.00	1.10	1.00	1.30	1.30
26	3.00	2.10	1.30	1.00	1.10	1.00	1.30	1.30
27	3.10	2.10	1.25	1.00	1.05	1.60	1.30	1.30
28	3.10	1.90	1.20	1.00	1.05	1.80	1.35	1.30
29	3.00	1.95	1.20	1.00	1.05	1.65	1.45	1.30
30	3.00	1.95	1.20	1.00	1.05	1.45	1.55	1.30
31	2.90	.....	1.20	1.00	.....	1.35	.....	1.30

KERN RIVER NEAR BAKERSFIELD, CAL.

This station, established in 1893 by Mr. Walter Jones, chief engineer of the Kern County Land Company, is located at what is known as First Point of Measurement, 5 miles above Bakersfield, and at the mouth of the canyon of the river. Meter measurements are taken once a week, and an automatic gage records daily fluctuations of the river heights. Mr. A. K. Warren, the engineer in charge of this work for the Kern County Land Company, attends to the discharge measurements with much accuracy and precision, and furnishes the Survey with the final results. The results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 468. A table is also given here furnishing a comparison of the mean monthly flow of the river from 1894 to 1901.

Daily discharge, in second-feet, of Kern River near Bakersfield, Cal., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	283	388	1,416	877	2,522	2,617	3,611	1,145	512	317	409	438
2	270	370	1,496	844	2,284	3,194	3,338	1,201	503	319	401	395
3	242	358	1,585	856	2,125	3,646	2,950	1,308	492	300	390	397
4	239	371	1,598	902	2,118	3,940	2,637	1,436	480	316	378	384
5	317	378	1,543	855	2,182	4,170	2,474	1,602	461	330	384	374
6	389	457	1,549	831	2,334	4,141	2,445	1,605	433	346	394	398
7	862	472	1,578	808	2,498	4,179	2,488	1,503	404	330	397	395
8	1,531	431	1,596	774	2,699	4,212	2,461	1,260	377	317	394	385
9	871	435	1,554	726	2,962	4,145	2,301	1,136	362	318	383	357
10	644	433	1,441	686	3,231	3,857	2,108	1,062	363	297	382	358
11	557	440	1,381	660	3,502	3,502	1,884	1,040	345	291	383	352
12	559	448	1,368	684	3,791	3,220	1,780	948	330	287	406	339
13	567	434	1,224	770	3,809	3,030	1,771	882	315	280	379	315
14	542	412	1,186	910	3,662	2,820	1,734	831	308	286	381	283
15	512	494	1,142	1,061	3,541	2,632	1,562	803	293	278	373	274
16	494	570	1,099	1,148	3,578	2,616	1,541	960	283	276	374	296
17	476	658	1,076	1,190	3,799	2,812	1,537	1,093	291	278	366	291
18	467	1,077	1,070	1,257	4,163	3,115	1,535	1,145	283	268	358	288
19	459	1,400	1,076	1,407	4,295	3,239	1,526	1,100	271	274	372	286
20	415	1,346	1,093	1,606	4,004	3,199	1,493	1,013	267	270	375	285
21	421	1,366	1,163	1,844	3,646	3,141	1,471	896	260	271	377	285
22	461	1,672	1,144	2,033	3,390	3,326	1,439	808	258	275	364	278
23	474	1,734	1,183	2,150	3,190	3,608	1,350	744	273	265	374	272
24	443	1,759	1,212	2,238	2,910	3,554	1,502	653	284	266	373	297
25	422	1,776	1,221	2,385	2,870	3,185	1,375	566	307	270	354	298
26	420	1,551	1,195	2,479	2,823	2,890	1,380	566	331	293	357	289
27	404	1,433	1,172	2,466	2,661	2,608	1,298	559	342	306	353	285
28	390	1,421	1,100	2,514	2,511	2,698	1,260	584	318	525	347	283
29	381	.....	1,055	2,509	2,365	3,002	1,244	526	307	500	364	281
30	389	.....	950	2,471	2,244	3,419	1,163	524	300	456	367	280
31	390	.....	912	.....	2,292	.....	1,127	516	.....	409	.....	284
Mean	493	860	1,270	1,398	3,032	3,324	1,864	968	345	317	377	323

Mean monthly discharge, in second-feet, of Kern River near Bakersfield, Cal.

Date.	1894.	1895.	1896.	1897.	1898.	1899.	1900.	1901.	Mean.
January	661	809	747	373	363	263	362	493	509
February	717	1,252	617	809	434	302	280	860	659
March	1,001	1,374	951	923	388	590	413	1,270	864
April	1,495	2,724	972	2,914	710	893	472	1,398	1,447
May	1,607	4,269	1,401	4,580	735	835	1,111	3,032	2,209
June	1,085	2,906	2,456	2,309	551	1,331	1,283	3,324	1,906
July	700	1,482	1,346	1,006	244	489	392	1,864	940
August	335	629	486	469	120	156	144	968	413
September	248	344	304	298	116	105	166	345	241
October	279	327	267	340	160	160	160	317	251
November	244	346	355	355	166	221	349	377	302
December	470	403	347	422	199	279	373	323	352
Mean	737	1,413	854	1,234	348	468	459	1,216	841

MOHAVE RIVER AT VICTORVILLE, CAL.

This station, established February 27, 1899, is at the wagon bridge at the gorge at Victorville known as The Narrows. It is described in Water-Supply Paper No. 51, page 463. Results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 503. During 1901 the following measurements of discharge were made under the direction of J. B. Lippincott.

List of discharge measurements of Mohave River at Victorville, Cal.

Date.	Gage height.	Discharge.	Total discharge, including leakage through dam.	Date.	Gage height.	Discharge.	Total discharge, including leakage through dam.
1901.	*Feet.*	*Sec.-ft.*		1901.	*Feet.*	*Sec.-ft.*	
February 25	1.40	66.4	66.4	August 8	.90	44.6	44.6
March 4	1.30	50.8	51.2	August 31	.90	49.0	54.8
March 25	.90	40.0	50.0	September 6	.90	48.7	48.7
April 9	.90	39.3	39.3	September —	.90	61.3	61.3
April 27	.90	40.4	48.4	October 5	.90	57.1	57.1
May 10	.85	43.4	47.4	October 24	.90	69.9	81.7
May 25	.85	48.5	50.5	November 6	.90	70.9	78.4
June 10	.85	37.2	43.2	November 24	.90	68.7	75.7
June 25	.90	37.5	41.5	December 10	.90	56.3	76.4
July 12	.90	34.2	40.2	December 25	.90	54.4	69.4
July 28	.90	35.8	41.6				

Daily gage height, in feet, of Mohave River at Victorville, Cal., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	0.90	0.90	1.40	0.90	0.90	0.85	0.90	0.90	0.90	0.90	0.90	0.90
2	.90	.90	1.40	.90	.90	.85	.90	.90	.90	.90	.90	.90
3	.90	.90	1.30	.90	.90	.85	.90	.90	.90	.90	.90	.90
4	.90	.90	1.30	.90	.90	.85	.90	.90	.90	.90	.90	.90
5	.90	2.60	1.20	.90	.85	.85	.90	.90	.90	.90	.90	.90
6	.90	4.00	1.20	.90	.85	.85	.90	.90	.90	.90	.90	.90
7	3.60	2.00	1.20	.90	.85	.85	.90	.90	.90	.90	.90	.90
8	1.00	1.60	1.20	.90	.85	.85	.90	.90	.90	.90	.90	.90
9	1.00	1.00	1.20	.90	.85	.90	.90	.90	.90	.90	.90	.90
10	.90	1.00	1.00	.90	.85	.90	.90	.90	.90	.90	.90	.90
11	.90	1.00	1.00	.90	.85	.90	.90	.90	.90	.90	.90	.90
12	.90	1.20	1.00	.90	.85	.90	.90	.90	.90	.90	.90	.90
13	.90	1.20	1.00	.90	.85	.90	.90	.90	.90	.90	.90	.90
14	.90	1.20	1.00	.90	.85	.90	.90	.90	.90	.90	.90	.90
15	.90	1.40	1.00	.90	.85	.90	.90	.90	.90	.90	.90	.90
16	.90	1.40	1.00	.90	.85	.90	.90	.90	.90	.90	.90	.90
17	.90	1.60	.90	.90	.85	.90	.90	.90	.90	.90	.90	.90
18	.90	1.60	.90	.90	.85	.90	.90	.90	.90	.90	.90	.90
19	.90	1.80	.90	.90	.85	.90	.90	.90	.90	.90	.90	.90
20	.90	1.90	.90	.90	.85	.90	.90	.90	.90	.90	.90	.90
21	.90	2.00	.90	.90	.85	.90	.90	.90	.90	.90	.90	.90
22	.90	2.00	.90	.90	.85	.90	.90	.90	.90	.90	.90	.90
23	.90	2.00	.90	.90	.85	.90	.90	.90	.90	.90	.90	.90
24	.90	1.50	.90	.90	.85	.90	.90	.90	.90	.90	.90	.90
25	.90	1.40	.90	.90	.85	.90	.90	.90	.90	.90	.90	.90
26	.90	1.40	.90	.90	.85	.90	.90	.90	.90	.90	.90	.90
27	.90	1.40	.90	.90	.85	.90	.90	.90	.90	.90	.90	.90
28	.90	1.40	.90	.90	.85	.90	.90	.90	.90	.90	.90	.90
29	.90	------	.90	.90	.85	.90	.90	.90	.90	.90	.90	.90
30	.90	------	.90	.90	.85	.90	.90	.90	.90	.90	.90	.90
31	.90	------	.90	------	.85	------	.90	.90	------	.90	------	.90

LOS ANGELES RIVER AT THE NARROWS, CALIFORNIA.

This stream is described in Water-Supply Paper No. 51, page 464. The measurement of this stream was discontinued by the city of Los Angeles at the close of 1900. The following measurements were made by William Mulholland in 1901.

The measurements were made at the first manhole above Bellevue reservoir diversion. The flow includes that of the Main supply ditch and of the Crystal Springs, the latter amounting to about 8.4 second-feet. This volume has not been included in previous measurements

of the river. The Main supply ditch was measured opposite the Crystal Springs.

	Discharge, sec.-ft.
January 15	53.9
April 24	51.4
June 4	46.4

ARROYO SECO, CALIFORNIA.

This stream is a tributary of Los Angeles River, which it joins at the city of Los Angeles. The station is described in Water-Supply Paper No. 39, page 410. During 1901 the following measurements were made at the cable station at the Terminal quarries by E. P. Dewey and W. B. Clapp:

List of discharge measurements of Arroyo Seco near Pasadena, Cal., in 1901.

	Discharge, sec.-ft.		Discharge, sec.-ft.
January 6	7	January 29	11
January 7	172	February 4	29
Do	103	February 5	869
January 8	28	Do	410
January 11	14	February 6	200
January 14	7	February 9	102
January 20	5	February 11	102
January 21	11	March 6	17
January 23	7	April 29	1.6
January 28	32	May 10	5

SAN GABRIEL RIVER ABOVE AZUSA, CAL.

This station is described in Water-Supply Paper No. 51, page 472. Results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 504.

Daily gage height of San Gabriel River above Azusa for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	Day.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	.....	1.90	3.40	1.95	2.80	1.35	17	1.30	4.00	2.20	1.50	1.40	....
2	.....	1.90	3.40	1.90	2.20	1.30	18	1.20	4.00	2.15	1.50	1.35	.....
3	.....	1.90	3.30	1.90	2.15	1.30	19	1.15	4.00	2.15	1.40	1.30	.....
4	.....	2.30	3.30	1.90	2.50	1.35	20	1.08	4.10	2.15	1.40	1.30	.....
5	.....	6.00	3.00	1.90	2.00	1.30	21	2.70	4.10	2.25	1.35	1.25	...
6	.....	5.00	2.95	1.80	1.95	1.20	22	2.35	4.20	2.10	1.35	1.20	...
7	5.00	4.40	2.90	1.80	1.90	1.10	23	1.95	4.10	2.10	1.15	1.20	...
8	3.50	4.50	2.80	1.80	1.80	1.02	24	1.80	4.00	2.05	1.15	1.30	...
9	2.50	4.20	2.70	1.75	1.75	1.02	25	1.80	3.80	2.05	1.15	2.20	...
10	2.20	3.90	2.70	1.75	1.70	1.02	26	1.80	3.60	2.00	1.15	1.80	....
11	2.00	3.60	2.65	1.75	1.60	1.00	27	1.90	3.50	2.00	1.15	1.60	.....
12	1.90	3.50	2.55	1.75	1.55	.....	28	2.20	3.40	2.25	1.10	1.60	.....
13	1.70	3.40	2.50	1.70	1.50	.....	29	2.00	.....	2.25	1.10	1.50	...
14	1.60	3.50	2.40	1.70	1.50	.....	30	1.90	.....	2.00	1.60	1.40	.....
15	1.50	3.80	2.30	1.65	1.50	.....	31	1.90	.....	2.00	.....	1.40	.....
16	1.40	3.80	2.20	1.60	1.45	.....							

Daily discharge, in second-feet, of San Gabriel canals, California, for 1901.

Day.	Jan.	Feb.	Mar.	Apr	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	28.0	67.0	70.0	55.0	72.0	66.0	41.0	23.5	15.0	21.0	36.0	29.0
2	28.0	67.0	70.0	55.0	72.0	66.0	41.0	24.2	15.0	20.0	34.0	29.0
3	28.0	67.0	70.0	55.0	59.0	66.0	41.0	25.0	[a]18.7	20.0	33.0	29.0
4	28.0	67.0	70.0	55.0	59.0	63.0	40.0	25.0	19.0	20.0	32.0	30.0
5	28.0	5.0	70.0	55.0	59.0	63.0	38.0	26.8	18.8	20.0	30.5	30.0
6	.....	70.0	70.0	68.0	59.0	63.0	36.0	24.0	19.2	[b]20.0	30.0	30.0
7	.....	70.0	70.0	60.0	59.0	63.0	34.0	23.4	19.0	17.0	30.0	30.0
8	35.0	70.0	69.0	56.0	67.0	63.0	33.0	23.0	17.9	15.5	30.0	29.0
9	90.0	70.0	69.0	56.0	67.0	63.0	33.0	22.0	17.3	16.0	30.0	28.7
10	78.0	70.0	69.0	56.0	67.0	63.0	32.5	21.0	17.2	16.0	50.0	29.0
11	71.0	70.0	69.0	56.0	68.0	63.0	32.0	20.0	16.8	15.5	46.0	29.0
12	70.0	70.0	69.0	56.0	68.0	62.0	32.0	20.0	16.6	14.5	36.0	29.0
13	69.0	70.0	69.0	56.0	68.0	62.0	31.5	21.0	16.4	14.5	35.0	29.0
14	69.0	70.0	69.0	59.0	68.0	60.0	30.0	19.5	16.4	14.5	34.0	29.0
15	68.0	70.0	69.0	63.0	68.0	60.0	30.0	19.5	15.9	15.0	33.0	29.5
16	68.0	70.0	69.0	63.0	68.0	60.0	30.0	19.5	16.0	15.5	32.5	29.0
17	67.0	70.0	68.0	70.0	68.0	55.0	29.0	19.0	15.7	15.5	32.0	28.5
18	66.0	70.0	68.0	70.0	68.0	54.5	28.0	21.0	15.8	15.5	32.0	28.5
19	66.0	70.0	68.0	70.0	68.0	54.0	27.0	19.3	15.6	16.0	31.0	28.5
20	66.0	70.0	68.0	70.0	65.0	53.5	28.0	19.0	15.7	15.5	31.0	28.5
21	77.0	70.0	35.0	71.5	65.0	50.0	29.0	19.0	16.5	14.5	31.0	28.0
22	73.0	70.0	57.0	71.5	65.0	49.5	27.0	18.5	18.6	14.5	30.0	28.0
23	70.0	70.0	57.0	82.0	65.0	49.5	26.0	18.0	19.6	16.0	29.0	27.0
24	69.0	70.0	57.0	82.0	66.0	49.5	25.0	17.0	20.4	17.0	29.0	27.0
25	68.0	70.0	57.0	82.0	66.0	52.0	24.7	15.7	19.1	18.0	30.0	27.0
26	68.0	70.0	57.0	82.0	66.0	48.5	24.2	15.0	17.9	64.0	30.0	27.0
27	68.0	70.0	57.0	82.0	66.0	45.5	24.2	15.0	17.5	52.0	29.0	26.0
28	71.0	70.0	39.0	82.0	66.0	43.5	24.2	15.0	17.3	56.0	29.0	26.0
29	70.0	.....	39.0	82.0	66.0	41.0	24.2	15.0	18.7	50.0	29.0	26.0
30	67.0	.....	55.0	84.0	66.0	41.0	25.0	15.0	20.4	.....	29.0	.....
31	67.0	.....	55.0	.....	66.0	.....	24.2	15.0	.....	.....	.....	.....

[a] Water turned off for twelve hours.
[b] September 3 to 30, weir measurements computed from record of continuous head.

LYTLE CREEK AT HEAD GATES OF RIALTO CANALS, CALIFORNIA.

The following record of daily flow of Lytle Creek, furnished through the courtesy of Mr. Thomas F. Keefe, secretary of the Fontana Development Company, has been obtained from measurements taken at the point of diversion of the Rialto canal system, which utilizes the entire summer flow of the creek. Previous records have been published in Water-Supply Paper No. 39, page 413, and in the Twentieth Annual Report, Part IV, page 555.

Daily discharge, in second-feet, of Lytle Creek, at head gates Rialto canals for 1901.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.[a]
1	..	21.7	14.0	11.3	10.5	9.5	11.0	17.6
2	..	20.4	15.2	11.6	10.0	9.5	10.8	17.3
3	..	19.8	14.6	11.3	10.2	9.2	10.8	18.5
4	..	18.5	14.3	11.1	10.8	9.2	10.8	18.8
5	..	13.8	13.2	10.5	10.8	9.5	10.8	18.5
6	..	14.9	13.2	10.2	11.0	9.7	10.5	18.5
7	..	15.2	13.2	10.5	11.3	9.7	10.5	..
8	..	15.1	14.6	10.2	11.3	9.7	12.6	..
9	..	14.3	13.2	10.2	11.0	10.0	12.4	..
10	..	12.1	12.4	10.0	10.5	9.7	12.1	..
11	..	12.7	12.9	9.7	10.2	9.5	11.8	..
12	..	13.5	12.7	9.5	10.5	9.5	12.1	..
13	..	14.0	12.7	9.5	10.5	9.2	12.4	..
14	..	14.3	..	9.5	10.5	9.2	12.4	..
15	..	14.3	12.9	9.5	10.5	9.0	12.6	..
16	..	16.1	12.1	9.5	10.2	9.0	13.2	..
17	..	16.1	12.1	9.5	10.2	8.7	12.6	..
18	..	16.1	12.1	9.5	10.0	9.0	13.2	..
19	..	16.1	12.1	8.7	10.0	9.2	13.2	..
20	..	16.1	12.4	9.0	10.2	9.5	12.6	..
21	..	15.8	12.4	9.5	10.5	9.7	12.6	..
22	..	14.9	11.6	9.2	10.8	11.3	13.5	..
23	..	14.9	11.8	9.5	10.5	11.5	14.0	..
24	..	15.8	12.9	..	10.5	11.0	14.0	..
25	..	18.5	12.7	..	10.0	10.8	15.8	..
26	..	16.7	12.1	..	10.2	10.5	(b)	..
27	16.1	16.1	11.6	..	10.2	10.5	(b)	..
28	16.1	16.1	11.0	..	10.0	10.2	(b)	..
29	16.1	16.1	11.0	..	10.0	10.8	16.1	..
30	16.1	16.1	10.5	..	10.0	11.3	16.1	..
31	..	15.2	..	..	9.7	..	15.8	..
Total	64.5	491.3	367.5	229.0	322.6	295.1	356.3	109.2

[a] No measurements taken in December on account of improvements being made.
[b] Heavy rain; water out of canal.

SANTA ANA RIVER BELOW WARMSPRINGS, CAL.

The original station was established in June, 1896, three-fourths of a mile below the head works of the Santa Ana Canal and opposite the warm springs in the canyon. It is described in Water-Supply Paper No. 51, page 475. It was found that this station could not be used during high water, and on January 1, 1901, observations were resumed at the old station and on Santa Ana Canal near the river station.

From June 1 to December 31, 1901, the discharge of Santa Ana River was obtained by observations on the weirs at the head works of Green Spot pipe line, Highlands canal, and Redlands canal; the water entering the Redlands canal from the Redlands tunnel and Morton Canyon were assumed to offset the loss by evaporation between the old gaging station and the mouth of the canyon.

Results of measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 504.

During 1901 the following discharge measurements were made under the direction of J. B. Lippincott:

List of discharge measurements of Santa Ana River below Warmsprings, Cal.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1901.	*Feet.*	*Sec.-ft.*	1901.	*Feet.*	*Sec.-ft.*
February 5	1.65	101	July 6	1.15	26
February 23	1.80	110	August 20	1.24	31
March 4	1.70	102	October 8	1.25	32
March 30	1.35	41			

Daily discharge in second-feet of Santa Ana River below Warmsprings, Cal., for 1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	31	48	114	56	63	36	41	41	60	51	34	24
2	31	48	114	56	48	37	37	48	53	55	36	24
3	31	440	114	48	42	36	35	[b] 44	52	50	29	24
4	31	485	102	42	42	35	36	39	53	50	26	24
5	31	476	91	42	42	35	40	37	50	49	25	24
6	36	540	91	42	36	35	40	42	51	48	25	24
7	48	540	80	42	36	34	36	44	45	46	25	25
8	600	395	80	36	36	32	35	38	47	48	25	25
9	125	178	80	36	36	32	34	40	42	47	24	24
10	114	150	80	36	36	34	36	35	44	45	30	24
11	114	150	80	36	36	35	38	37	48	42	29	24
12	114	125	80	35	36	31	36	35	49	42	26	25
13	93	102	74	36	36	31	35	43	49	44	26	24
14	93	102	63	36	36	32	35	41	49	46	25	21
15	63	102	56	36	36	30	37	43	48	48	25	22
16	48	102	48	36	36	[a] 33	37	49	49	49	26	24
17	48	102	48	36	36	33	36	[b] 200	47	51	25	25
18	48	102	48	36	36	41	36	[b] 75	50	51	24	24
19	48	125	48	36	36	42	36	[b] 50	51	51	24	23
20	80	138	48	36	36	43	37	31	49	48	26	23
21	80	138	48	36	36	41	37	[b] 34	48	50	25	24
22	48	138	48	36	36	41	40	[b] 37	54	45	24	24
23	48	138	48	36	36	44	42	[b] 40	47	48	22	24
24	48	114	48	36	36	44	41	43	51	46	24	24
25	48	114	42	36	36	40	37	51	50	44	24	24
26	48	102	42	36	36	40	38	51	47	[b] 96	23	23
27	63	114	42	36	36	40	39	55	47	65	24	23
28	63	114	42	36	36	37	38	54	49	27	24	22
29	48	.....	42	36	31	36	37	55	48	24	24	22
30	48	.....	42	102	31	37	40	58	52	26	24	24
31	48	.....	56	.....	31	.....	41	60	.....	48	.....	24
Mean	78	194	68	43	42	37	38	50	49	48	26	24

[a] Ten second-feet turned out of Bear Valley reservoir.
[b] Water cut off at Bear Valley dam.

Daily discharge, in second-feet, of Green Spot pipe line, Santa Ana River, at head-works weir, for 1901.

Date.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.0	3.5	2.5	6.0	6.0	3.0	1.3
2	.5	3.5	2.5	6.0	6.0	3.0	1.3
3	.5	3.5	2.5	6.0	6.0	2.0	1.6
4	.5	3.5	2.5	6.0	6.0	2.0	1.7
5	.5	3.5	2.5	6.0	6.0	2.0	1.7
6	.5	3.5	0.0	6.0	6.0	0.0	1.8
7	.5	1.6	3.0	6.0	6.0	0.0	1.1
8	.5	1.6	3.0	6.0	6.0	0.0	1.2
9	.5	1.6	3.0	6.0	6.0	0.0	1.8
10	.5	1.6	3.0	6.0	6.0	1.7	1.8
11	1.5	1.6	3.0	6.0	6.0	3.5	1.4
12	1.5	1.6	5.5	6.0	4.0	2.6	1.3
13	1.5	1.6	2.5	6.0	4.0	2.6	1.3
14	1.5	1.8	2.5	6.0	4.0	3.7	1.6
15	1.5	1.8	2.5	6.0	4.0	4.5	1.4
16	1.5	1.8	2.5	6.0	6.0	4.3	1.5
17	1.5	1.8	0.0	4.0	6.0	.5	1.8
18	2.5	1.8	0.0	4.0	6.0	.5	1.5
19	2.5	1.8	0.0	4.0	6.0	.5	1.8
20	3.5	1.8	0.0	4.0	6.0	0.0	1.6
21	3.5	1.8	0.0	4.0	6.0	0.0	1.6
22	0.0	2.5	0.0	4.0	6.0	1.5	1.6
23	3.5	2.5	0.0	4.0	6.0	1.5	0.0
24	3.5	2.5	2.5	6.0	6.0	1.6	0.0
25	2.5	2.5	3.0	6.0	6.0	1.8	0.0
26	2.5	2.5	5.0	6.0	6.0	2.1	0.0
27	2.5	2.5	5.0	6.0	6.0	1.8	0.0
28	2.5	2.5	8.0	6.0	6.0	1.8	0.0
29	3.8	2.5	6.0	6.0	6.0	1.6	0.0
30	3.5	2.5	6.0	6.0	6.0	1.3	2.5
31	.....	2.5	6.0	.....	6.0	.....	2.5

Daily mean discharge, in second-feet, of Highlands canal, Santa Ana River, at Sand Box weir, for 1901.

Day.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	12.7	14.7	14.6	16.5	16.3	8.8	7.9
2	11.7	14.2	13.6	16.5	15.9	9.0	7.9
3	11.3	12.5	.....	16.5	14.4	9.8	7.7
4	12.1	12.0	13.0	16.5	14.4	8.8	8.2
5	11.4	12.6	12.4	16.5	14.3	8.8	8.2
6	11.5	13.9	14.1	15.4	14.1	8.2	10.0
7	12.2	13.8	15.8	16.5	13.8	8.4	7.4
8	12.3	14.9	14.4	15.8	14.3	10.5	7.4
9	11.1	14.4	14.5	12.8	14.5	10.5	7.0
10	11.9	14.9	14.5	16.2	14.1	9.5	7.4
11	12.7	15.3	15.4	16.1	14.3	9.2	7.2
12	12.7	14.7	14.6	16.1	14.3	10.3	6.7
13	12.0	14.6	15.3	15.2	13.4	10.8	6.7
14	12.0	14.7	15.4	15.4	12.1	10.0	7.0
15	10.0	15.3	16.0	14.5	14.3	9.2	6.3
16	11.3	15.3	19.4	15.4	13.1	9.5	7.0
17	11.1	14.7		16.1	13.3	10.4	7.0
18	11.1	15.4	13.0	15.8	15.0	9.5	7.0
19	11.1	12.9	13.1	16.5	14.5	9.5	7.2
20	14.6	12.8	12.0	16.4	14.2	7.7	7.4
21	14.6	12.3	.....	14.3	14.5	8.9	7.4
22	14.0	14.6	.....	15.4	12.0	7.9	7.2
23	13.9	15.3	6.0	14.5	12.1	9.5	7.2
24	14.1	14.2	12.0	14.6	14.3	11.1	7.2
25	14.4	14.2	17.5	16.3	12.0	9.7	7.2
26	13.9	15.0	17.5	16.3	12.1	9.2	7.0
27	14.9	14.6	17.5	16.5	11.0	10.0	7.0
28	14.0	14.4	17.5	16.5	9.0	8.2	7.2
29	14.3	15.1	17.5	13.9	8.8	8.2	7.2
30	14.1	14.4	17.5	16.3	11.2	9.2	7.2
31	.....	14.2	17.5	.....	12.0	.....	7.2

Daily discharge, in second-feet, of Redlands canal, Santa Ana River, at Sand Box weir, for 1901.

Day.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	20.0	22.7	23.9	37.3	28.6	22.0	14.9
2	24.6	18.9	31.4	30.0	32.9	24.0	14.9
3	24.0	18.9	.....	29.3	30.0	17.1	14.4
4	22.0	20.7	23.3	30.2	30.0	15.3	13.8
5	23.3	23.7	22.0	27.3	28.6	14.0	13.8
6	22.7	22.8	27.9	29.3	28.0	16.6	12.0
7	20.8	20.7	25.2	23.3	26.6	16.9	16.4
8	19.5	18.9	20.7	25.3	28.0	14.1	16.4
9	20.6	18.3	22.0	23.3	26.6	13.8	15.2
10	21.4	19.5	17.1	21.4	25.3	18.6	14.7
11	20.7	20.7	18.9	25.9	21.4	16.1	15.2
12	17.1	19.5	14.8	27.3	23.3	13.6	16.6
13	17.7	18.9	25.2	28.0	26.6	12.5	16.4
14	18.3	18.9	23.3	28.0	29.5	11.4	12.8
15	18.9	19.5	24.6	27.3	30.0	10.9	14.1
16	20.1	19.5	27.4	27.3	30.0	12.0	15.8
17	20.7	19.5	0.0	27.3	31.4	13.8	15.8
18	27.3	18.3	0.0	30.0	30.0	14.1	15.2
19	28.6	21.4	11.6	30.0	30.0	14.1	14.1
20	24.6	22.6	9.3	28.6	28.0	17.8	14.1
21	22.6	22.6	34.3	30.0	29.4	16.4	14.9
22	27.3	23.3	11.6	34.3	27.0	14.9	14.9
23	26.6	24.6	28.0	28.6	29.4	11.2	16.4
24	26.6	23.9	28.0	30.0	25.8	11.2	16.6
25	23.3	20.7	30.0	27.6	26.0	12.2	16.4
26	23.3	20.7	28.0	24.6	28.0	12.0	15.8
27	22.6	21.4	32.9	24.6	17.0	12.0	15.8
28	20.7	20.7	28.6	26.6	12.0	14.4	15.2
29	18.3	18.9	31.4	27.9	9.0	14.4	14.9
30	18.9	22.6	34.3	30.0	9.0	13.6	13.8
31	.....	24.6	36.4	.....	30.0	.....	13.8

MILL CREEK CANALS AT CRAFTON HEADWORKS, CALIFORNIA.

This station is described in Water-Supply Paper No. 51, page 476. The Crafton Water Company diverts all of the water of the creek, except during floods, at the mouth of the canyon. The water passes over a weir, and the volume therefore is determined with considerable accuracy. The following tables, furnished by the Crafton Water Company, give the daily discharge of the creek entering the canal. No record is given for the period from January 1 to June 18; the flow during this time, taken from the canals, is estimated at 10 second-feet. The results of the measurements for 1900 will be found in the Twenty-second Annual Report, Part IV, page 505.

Daily discharge, in second-feet, of Mill Creek canals at Crafton headworks, Cal., for 1901.

Day.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1		19.00	50.00	16.00	13.18	12.30	11.70
2		19.12	30.00	16.00	13.18	12.30	10.26
3		19.00	20.00	16.00	13.18	12.30	11.10
4		19.00	20.00	16.58	13.18	12.30	12.28
5		18.00	20.00	16.58	13.18	12.30	12.28
6		16.96	19.10	16.58	13.18	12.30	12.10
7		16.96	19.10	16.58	13.18	12.30	12.10
8		16.80	18.00	16.00	13.18	12.30	12.10
9		16.80	16.08	16.60	12.80	12.30	12.10
10		16.00	16.08	14.04	12.64	12.30	12.10
11		16.00	16.08	14.00	12.64	12.30	12.10
12		16.00	18.24	14.00	12.64	12.30	12.10
13		16.00	16.96	14.00	12.30	12.30	12.10
14		15.04	16.96	14.00	12.30	12.30	12.10
15		15.04	16.96	13.18	12.30	12.30	12.10
16		15.04	(a)	13.18	12.30	12.30	12.10
17		15.04		13.18	12.30	12.30	12.10
18		15.04		12.30	12.30	12.30	12.10
19	20.08	14.40		12.30	12.30	12.30	12.10
20	20.08	13.94		12.30	12.30	12.30	12.10
21	21.00	14.40		11.42	12.30	12.30	12.10
22	20.90	14.40		11.42	12.30	12.30	12.10
23	20.40	13.94		12.30	12.30	12.30	12.10
24	20.08	13.94	16.00	12.30	12.30	12.30	12.10
25	20.08	14.40	16.00	14.58	12.30	12.30	12.10
26	20.00	14.40	15.04	13.18	12.30	12.30	12.10
27	19.80	16.96	15.04	13.18	12.30	12.30	12.10
28	19.80	15.04	15.04	13.18	12.30	12.30	12.10
29	19.50	15.04	16.00	13.18	12.30	12.30	12.10
30	19.40	15.04	16.00	13.18	12.30	11.60	12.10
31		15.04	16.00		12.30		12.10

a On August 16 a cloudburst in Mill Creek Canyon and Crafton hills filled zanja and supply canal with sand.

SWEETWATER RIVER AT SWEETWATER DAM, CAL.

This stream has its source on the western slope of the Cuyamaca Mountains, in the extreme southern part of San Diego County, Cal., adjoining Mexico.

Observations of the discharge of this river into the Sweetwater reservoir have been made by H. N. Savage, chief engineer of the Sweetwater Irrigation System. The measurements are of particular accuracy, because the capacity of the reservoir is definitely known, and the readings of the gage rod in the reservoir indicate volumes discharged. The discharge from this watershed of 186 square miles

during the winter of 1900–1901 was 861 acre-feet, the rainfall as measured at the dam being 11 inches.

MISCELLANEOUS DISCHARGE MEASUREMENTS IN CALIFORNIA.

Date.	Stream.	Location.	Discharge in second-feet.
1901.			
September 10	Upper Sacramento River	1 mile above mouth of Pitt River	242
September 9	McCloud River	One-quarter mile above United States fishery.	1,096
Do	Squaw Creek	Copper City Bridge	23
Do	Pit River	Silverthorn Ferry, near Copper City	2,682
Do	do	Pecks Bridge	2,230
Do	Fall River	Fall River Bridge, near mouth	1,447
Do	Hat River	Bridge Carbon, Cal., near mouth	625
Do	Burney River		177
October 2	Sacramento River	Iron Canyon, 4 miles above Red Bluff	5,187
November 21	Briscoe River	Above proposed dam site	10.4
November 22	Grindstone River		38
September 7	Feather River	500 feet above Oroville Bridge	1,220
Do	Feather River, North Fork.	Huffs Bar in Big Bend	946
Do	Feather River, West Branch of North Fork	Cherokee Pipe Crossing, near Cherokee, Cal.	33
September 19	American River, South Fork.	Mosquito Bar	69
September 13	do	Riverton	25
September 18	do	do	16
Do	Eldorado ditch	Above Riverton	23
September 13	American River, South Fork Silver Creek.		28
September 14	American, South Fork Main Forks.		40
August 31	Tuolumne, Lagrange ditch and Hydraulic Mining Co.'s canal.	Lagrange, Cal	4
October 11	Tuolumne	Old Bridge above Rancheria Creek	60
August 26	Tuolumne, Rancheria Creek.	Hetch Hetchy Valley	36.2
August 27	Tuolumne, Eleanor Creek Inlet.		9.3
September 19	Tuolumne, Falls Creek		3
October 16	San Joaquin	Pollasky Ford, Cal	315
October 17	Salinas River	Bridge near Salinas	24
September 24	Arroyo Seco	Pettitts ranch	9.7
April 15	San Lorenzo Creek		21
July 11	San Antonio Creek		.64
July 12	Nacimiento Creek	Harris ranch	3.8
October 20	Kaweah River	Below headworks Watumna ditch	52
Do	Watumna ditch		5
Do	Pogue lower ditch		5
July 29	South Tule River	Near mouth	.5
May 23	Tule River[a]	6 miles west of Portersville, Rockford Bridge.	152.4
June 24	Lower Tule River[b]	Canal at Tulare Lake	198.2
June 28	Tule River	Globe post-office	164.6
Do	do	McFarland's ranch	147.6
September 22	Kern River	First point of measurement	258
July 12	Pacoima River	Mouth of canyon	Dry.
Do	do	Submerged dam pumping	.41
Do	Little Tujunga River		Dry.
Do	Tujunga River		.22
September 20	Los Angeles River	Bridge No. 2	15.9
September 19	San Gabriel River	Intake weir of San Gabriel Power Co.'s canal.	15.6
October 7	San Antonio Creek	Division weir in canyon to Ontario, 3.08; to Pomona, 2.91.	5.99
Do	Cucamonga Creek		2.06
December 5	Santa Ana River	Warmsprings	14
Do	Santa Ana Canal		9.7

[a] This point is below nearly all of the important ditches taking water from the Tule River.
[b] The above represents the unused water flowing through the canal into the lake. This water came from Elk Canyon, one of the numerous channels of the Kaweah. At this date the Tule River was practically dry at Rockford Bridge.

PRECIPITATION ON MOUNTAINS IN SOUTHERN CALIFORNIA.

In order to obtain rainfall data bearing upon river discharge a number of rainfall gages have been established at various points in the mountainous region of California. Results obtained at these localities during 1901, together with a few figures from other sources, are given in the following tables. The first table gives the location of the rainfall stations; the second table gives the depth of rainfall, in inches, for each month of the year. Similar figures for 1896 are given in the Eighteenth Annual Report, Part IV, page 418; for 1897, in the Nineteenth Annual Report, Part IV, page 539; for 1898, in the Twentieth Annual Report, Part IV, page 560; for 1899, in Water-Supply Paper No. 39, page 437; and for 1900, in Water-Supply Paper No. 52, page 495:

Rainfall stations in southern California.

Station.	County.	Post-office.	Latitude.		Longitude.		Elevation.
			°	′	°	′	*Feet.*
Alturas	Modoc	Alturas	41	30	120	30	4,300
Sisson	Siskiyou	Sisson	41	27	122	25	3,555
Dunsmuir	do	Dunsmuir	41	15	122	40	2,283
Delta	Shasta	Delta	40	58	122	27	1,136
Redding	do	Redding	40	30	122	40	565
Red Bluff	Tehama	Red Bluff	40	12	122	20	324
Julians	Glenn	Elk Creek	39	30	122	30	750
Lakeport	Lake	Lakeport	39	00	123	00	.....
Sonora	Tuolumne	Sonora	38	00	120	16	1,824
Second Garotte	do	Groveland	37	49	120	12	2,900
Crockers	do	Sequoia	37	48	119	53	4,453
Coulterville	Mariposa	Coulterville	37	43	120	12	1,660
Taylor's ranch	Kern	Weldon	36	20	118	17	2,640
Milo	Tulare	Milo	36	15	118	50	3,200
Priest Valley	Monterey	Soledad	36	15	120	45	2,400
Isabella	Kern	Isabella	35	48	118	25	2,600
Kernville	do	Kernville	35	45	118	25	2,600
Bear Valley	do	Tehachapi	35	15	118	45	4,000
Tejon ranch	do	Bakersfield	35	00	118	45	1,450
Fort Tejon	do	do	34	53	118	53	3,245
Glen ranch	San Bernardino	Cajon	34	50	117	30	3,112
Smith ranch	Ventura	Gorman	34	44	118	47	4,850
Upper Lake	do	Upper Lake	.....		.....		4,900
Sneddens	do	Griffin	34	4	119	03	4,900
Colby's Camp, No. 5	Los Angeles	Pasadena	34	30	118	15	3,875
Palmdale headworks	do	Palmdale	34	25	118	03	3,299
Magic Hill, No. 1	do	Burbank	34	23	118	22	2,820
Mount Sister Elsie	do	Monte Vista	34	17	118	14	5,021
Sierra Power House	do	.....	34	15	117	45	.....
Headgate	do	.....	34	15	117	45	.....
Power House	do	.....	34	15	117	45	.....
Follows Camp	do	Azusa	34	14	117	49	1,800
Mill Creek "A"	San Bernardino	Redlands	34	10	116	45	5,300
Santa Ana Canyon	do	.....	33	45	117	45	.....
Mutah Flat	Ventura	Griffin	34	38	119	03	4,850
Cuyamaca	San Diego	San Diego	32	58	115	35	4,800
Descanso	do	Descanso	32	50	116	40	3,500
Laguna	do	Campo	32	45	116	30	5,760
Sweetwater dam	do	National City	32	43	117	00	250
La Mesa	do	La Mesa	32	30	117	00	475
Campo	do	Campo	32	15	116	30	2,660

Precipitation at rainfall stations in southern California, 1901.

Station.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Alturas	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.83	0.74	1.21	.....
Sisson	11.97	8.99	0.62	2.73	0.95	0.00	0.26	0.36	2.08	1.93	6.58	2.77	39.24
Dunsmuir	8.93	6.90	1.92	2.58	T.	.00	.00	.00	.00	.00	10.88	5.06	36.27
Delta	13.43	8.18	1.58	6.81	.65	.00	.00	.00	2.28	2.95	11.27	5.55	52.70
Redding	6.33	5.52	.57	5.11	.41	T.	.01	T.	3.11	3.08	6.45	4.37	34.96
Red Bluff	6.60	6.64	.12	2.06	.41	T.	T.	.00	1.84	2.06	4.22	1.56	25.51
Julians	.....	4.20	.12	1.24	.50	.00	.00	.00	1.07	.60	3.18	.82	11.79
Lakeport	9.20	3.95	1.25	2.15	.62	.00	.00	.00	.88	2.20	4.18	.00	24.43
Sonora	9.04	12.89	1.25	4.73	1.18	.07	.00	.04	2.42	1.81	3.15	2.40	38.99
Second Garotte	11.00	17.75	1.25	4.00	1.00	.00	.00	.00	2.25	2.25	2.00	2.00	43.50
Crockers	16.99	15.71	3.03	6.35	3.81	.00	.00	.00	3.28	4.59	3.90	2.50	60.16
Coulterville	4.99	8.04	1.28	.66	3.29	T.	T.	T.	1.35	1.92	2.09	1.39	25.01
Taylor's ranch	1.06	1.96	.05	.41	1.02	.00	.00	2.60	.00	.39	.12	.00	7.61
Milo	5.74	4.06	1.33	2.45	3.36	.00	.00	.00	.51	1.80	1.47	.27	20.99
Priest Valley	6.27	9.51	.80	2.44	1.59	.00	.00	.00	.00	2.57	2.08	.66	25.92
Isabella	1.20	2.74	.33	.36	1.98	.00	.00	.99	.00	.64	.13	.00	8.37
Kernville	1.35	2.92	.15	.31	1.62	.00	.00	.70	.00	.72	.15	.00	7.92
Bear Valley	1.91	5.30	2.75	1.77	1.43	.00	T.	.00	.00	1.27	.56	.90	15.89
Tejon ranch	1.28	4.69	.95	1.36	1.28	.00	.00	T.	.00	.40	.17	.60	10.73
Fort Tejon	1.80	5.86	1.97	.78	.90	.00	.00	T.	.05	1.61	.26	T.	13.23
Glen ranch	6.53	9.78	.43	1.40	.96	.00	.00	.00	.00	2.61	.58	.10	22.39
Smith ranch	2.35	2.25	.10	.32	.45	.00	.00	.95	.10	.25	.20	.00	6.97
Upper Lake	6.44	4.75	1.06	2.43	.70	.00	T.	T.	1.11	1.09	4.35	2.09	24.02
Sneddens	3.70	3.80	.10	1.10	.47	.00	.00	.00	.00	1.75	1.75	.00	12.67
Colby's Camp, No. 5	6.94	13.54	.67	2.65	1.10	.....	.....	.....	.....	.....	.....	.....	.....
Palmdale Headworks	1.34	4.50	.38	.15	T.	.00	.00	.33	T.	.32	.04	.00	7.06
Magic Hill, No. 1	6.71	6.68	.78	1.79	.57	.....	.....	.....	.....	.....	.....	.....	.....
Mount Sister Elsie	8.92	12.13	.95	3.60	1.93	.....	.....	.....	.....	.....	.....	.....	.....
Sierra Power House	10.35	8.15	.78	.36	2.78	.01	.00	.00	.00	3.99	.97	.24	27.63
Headgate	6.44	5.09	.48	1.15	2.90	.00	.00	.02	.00	4.58	1.08	.18	21.92
Power House	5.23	3.81	.58	1.35	1.87	.00	.00	.03	.00	3.15	.64	.00	16.66
Follows Camp	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.80	.15	.....
Mill Creek, "A"	4.32	6.00	.71	.39	1.85	.00	.00	1.20	.00	1.95	.82	.00	17.24
Santa Ana Canyon	5.24	5.77	1.05	1.26	1.17	.00	.00	1.25	.00	1.16	.11	.00	17.01
Mutah Flat	7.00	4.60	.25	1.10	.58	.00	.00	.00	.00	2.85	.65	.00	17.03
Cuyamaca	8.17	13.26	2.32	1.24	3.87	.00	T.	.09	.08	1.94	1.48	.52	32.97
Descanso	3.25	11.00	1.40	.57	1.53	.00	T.	.78	T.	1.25	.87	.12	20.77
Laguna	5.60	8.60	.95	.71	2.09	.00	.42	1.25	.00	1.42	.54	.35	21.93
Sweetwater dam	1.75	4.22	.54	.11	.74	.00	.00	.00	.03	.46	.19	.00	8.04
La Mesa	2.82	5.99	.97	.75	.47	.00	.00	.00	.05	.45	.58	.00	12.08
Campo	2.03	8.22	.69	.54	1.18	.00	.61	.63	.00	1.02	.43	.23	15.58

RATING TABLES.

Rating tables for stations in Montana, Wyoming, and South Dakota.

[Discharge in second-feet.]

Gage height, in feet.	St. Mary River at Main, Mont.	Milk River at Havre, Mont.	Milk River at Havre, Mont.	West Gallatin River near Salesville, Mont.	Madison River near Redbluff, Mont.	Jefferson River at Sappington, Mont.	Missouri River near Townsend, Mont.	Yellowstone River near Livingston, Mont.	Yellowstone River near Livingston, Mont.	Bighorn River near Thermopolis, Wyo.	Big Sioux River near Sioux Falls, S. Dak.	Medicine Bow River at Medicine Bow, Wyo.
−1.1		[a]	[b]				[c]	[d] 1,265	[e] 1,380			
−0.8								1,420	1,520			
−0.6								1,585	1,700			
−0.4								1,760	1,900			10
0.2								1,950	2,100	60		25
0.0	215						1,200	2,150	2,320	210		45
0.2	238						1,590	2,375	2,560	400		70
0.4	278						2,020	2,605	2,820	620		100
0.6	345						2,490	2,855	3,100	940		136
0.8	425						3,020	3,130	3,380	1,340		178
1.0	505				950		3,630	3,420	3,660	1,770	11	235
1.2	587				1,175	430	4,270	3,730	3,980	2,210	17	310
1.4	677				1,475	550	4,930	4,075	4,300	2,650	26	390
1.6	795		12		1,900	680	5,600	4,440	4,700	3,090	37	480
1.8	984		15		2,400	820	6,285	4,830	5,100	3,530	53	570
2.0	1,220		23		2,975	975	7,000	5,275	5,500	3,970	76	660
2.2	1,456		40		3,575	1,155	7,760	5,740	6,000	4,410	104	750
2.4	1,692	115	65		4,175	1,375	8,555	6,220	6,500	4,850	146	840
2.6	1,928	155	95		4,775	1,635	9,375	6,730	7,030	5,290	198	930
2.8	2,164	205	130	455	5,400	1,950	10,220	7,270	7,610	5,730	250	1,020
3.0	2,400	255	175	495	6,050	2,290	11,100	7,840	8,230	6,170		1,110
3.2	2,636	305	230	535	6,700	2,630	12,015	8,470	8,850	6,610		1,200
3.4		360	290	590	7,350	2,980	12,960	9,140	9,550	7,050		1,290
3.6		420	350	660	8,000	3,340	13,930	9,860	10,350	7,490		1,380
3.8		480	425	750	8,650	3,710	14,925	10,800	11,200	7,930		1,470
4.0		540	500	915	9,300	4,090	15,950	11,900	12,200	8,370		1,560
4.2		630	600	1,160		4,480	17,040	13,150	13,250	8,810		1,650
4.4		730	700	1,440		4,880	18,210	14,450	14,450	9,250		1,740
4.6		830	820	1,720		5,300	19,450	15,800	15,800	9,690		1,830
4.8		950	950	2,000		5,730	20,760	17,230	17,230	10,130		1,920
5.0		1,100		2,300		6,170	22,150	18,660	18,660	10,570		2,010
5.2		1,340		2,620		6,630	23,650	20,090	20,090	11,010		
5.4		1,580		2,940		7,100	25,410	21,520	21,520	11,450		
5.6		1,820		3,260		7,580	27,490	22,950	22,950			
5.8		2,060		3,590		8,075	29,830	24,380	24,380			
6.0		2,300		3,940		8,575		25,810	25,810			
6.2		2,540		4,310		9,075						
6.4		2,780		4,720								
6.6		3,020		5,170								
6.8		3,260		5,660								
7.0		3,500		6,190								
7.2		3,740		6,760								
7.4		3,980		7,360								
7.6				7,960								

[a] Applicable from January 1 to June 14, 1901.
[b] Applicable from June 15 to November 21, 1901.
[c] 88 feet should be added to the gage heights in order to refer them to the datum of the gage.
[d] Applicable from January 1 to May 20, 1901.
[e] Applicable from May 21 to December 31, 1901.

Rating tables for stations in Wyoming, Colorado, Nebraska, and Kansas.

[Discharge in second-feet.]

Gage height, in feet.	North Platte River near Guernsey, Wyo.	South Platte River at Denver, Colo.	Bear Creek near Morrison, Colo.	Clear Creek at Forkscreek, Colo.	South Boulder Creek near Marshall, Colo.	Boulder Creek near Boulder, Colo.	St. Vrain Creek near Lyons, Colo.	Big Thompson Creek near Arkins, Colo.	South Platte River at Kersey, Colo.	Elkhorn River near Norfolk, Nebr.	Republican River near Superior, Nebr.	Republican River at Junction, Kans.
0.2	[a]1,305							4			52	
0.4	1,550					22		19			85	
0.6	1,805					47		60			148	
0.8	2,075					77		116		140	240	
1.0	2,400		9		5	115		177		162	370	
1.2	2,820		12		17	161		239	62	192	560	
1.4	3,280		15	32	34	220		305	138	227	810	
1.6	3,810		19	58	57	292		378	214	270	1,112	
1.8	4,340		23	93	86	367	4	461	290	319	1,422	
2.0	4,870		27	133	119	444	25	556	370	370	1,747	
2.2	5,400		31	179	157	522	53	671	450	425	2,092	
2.4	5,930		36	235	206	603	87	813	540	493	2,482	20
2.6	6,460		41	299	263	688	126	990	646	575	2,907	75
2.8	6,990		46	367	324	778	171	1,190	771	668	3,352	150
3.0	7,520		51	441	394	870	223	1,390	927	763	3,817	230
3.2	8,050		56	522	473		286	1,590	1,137	860	4,307	315
3.4	8,580		62	614	559		362	1,790	1,398	971	4,822	405
3.6	9,110		69	719	652		478	1,990	1,675	1,087	5,357	510
3.8	9,640		77	832	750		604		1,955	1,205	5,912	625
4.0	10,170	10	85	946	850		730		2,235	1,334	6,487	770
4.2	10,700	12	96	1,060			857		2,519	1,444		930
4.4	11,230	18	110	1,174					2,803	1,577		1,100
4.6	11,760	36	132	1,288					3,087	1,705		1,300
4.8	12,290	70	160	1,402					3,371	1,843		1,520
5.0	12,820	113	198						3,655	1,980		1,750
5.2	13,350	160	240						3,939	2,135		1,995
5.4	13,880	213	283						4,223	2,300		2,265
5.6		273	326						4,507	2,480		2,555
5.8		341	368						4,791	2,660		2,850
6.0		422	411						5,075	2,840		3,160
6.2		540								3,020		3,535
6.4		686								3,200		3,990
6.6		848								3,380		4,470
6.8		1,026								3,560		5,010
7.0		1,220										
7.2		1,450										
7.4		1,755										
7.6		2,077										
7.8		2,399										
8.0		2,723										
8.2		3,047										
8.4		3,371										
8.6		3,696										
8.8		4,022										
9.0		4,348										
9.2		4,674										
9.4		5,000										
9.6		5,326										
9.8		5,652										

[a] Continued: Gage height −1.0, discharge 80; gage height −0.8, discharge 230; gage height −0.6, discharge 420; gage height −0.4, discharge 630; gage height −0.2, discharge 845; gage height 0.0, discharge 1,070.

Rating tables for stations in Kansas and Colorado.

[Discharge in second-feet.]

Gage height in feet.	Solomon River near Niles, Kans.	Saline River near Salina, Kans.	Smoky Hill River at Ellsworth, Kans.	Blue River near Manhattan, Kans.	Kansas River at Lecompton, Kans.	Arkansas River near Canyon, Colo.	Arkansas River at Pueblo, Colo.	Arkansas River near Nepesta, Colo.	Arkansas River at Prowers, Colo.	Arkansas River at Hutchinson, Kans.	Verdigris River near Liberty, Kans.	Neosho River near Iola, Kans.
0.0	.....	.....	.....	.....	.....	[a]	.....	.....	15	.....	.....	.....
0.2	.....	.....	.....	.....	.....	.....	.....	.....	61	.....	.....	.....
0.4	.....	.....	.....	.....	.....	.....	.....	140	120	.....	.....	.....
0.6	.....	.....	7	.....	.....	.....	.....	190	250	.....	.....	22
0.8	.....	.....	14	.....	.....	.....	.....	350	658	23	.....	46
1.0	.....	.....	23	.....	.....	.....	.....	717	1,130	45	.....	70
1.2	.....	.....	50	.....	.....	.....	.....	1,165	1,602	80	2	94
1.4	.....	.....	81	.....	.....	.....	174	1,616	2,074	120	5	118
1.6	.....	.....	120	.....	.....	.....	254	2,068	2,546	165	10	142
1.8	.....	.....	165	.....	.....	.....	338	2,520	3,018	220	27	166
2.0	.....	.....	227	.....	275	270	430	2,972	3,490	295	55	190
2.2	.....	.....	310	.....	625	323	556	3,424	3,962	400	90	240
2.4	.....	.....	398	.....	1,000	377	698	3,876	.....	530	140	310
2.6	.....	.....	486	.....	1,425	442	852	4,328	.....	715	205	400
2.8	.....	.....	574	.....	1,885	535	1,014	4,780	.....	960	280	500
3.0	.....	25	662	150	2,375	650	1,185	5,232	.....	1,250	368	610
3.2	.....	31	.....	200	2,890	780	1,367	.....	.....	1,550	464	750
3.4	.....	37	.....	270	3,415	937	1,560	.....	.....	1,875	560	900
3.6	.....	43	.....	340	3,940	1,135	1,762	.....	.....	2,300	660	1,070
3.8	.....	51	.....	420	4,465	1,357	1,974	.....	.....	2,820	760	1,270
4.0	22	60	.....	500	5,000	1,579	2,200	.....	.....	.....	860	1,500
4.2	38	71	.....	590	5,550	1,801	2,452	.....	.....	.....	960	1,760
4.4	54	85	.....	680	6,120	2,023	2,736	.....	.....	.....	1,060	2,050
4.6	70	100	.....	770	6,710	2,245	3,058	.....	.....	.....	1,164	2,380
4.8	80	115	.....	860	7,300	2,467	3,416	.....	.....	.....	1,280	2,720
5.0	100	130	.....	960	7,900	2,689	3,780	.....	.....	.....	1,400	3,060
5.2	128	145	.....	1,060	8,510	2,911	4,144	.....	.....	.....	1,520	3,400
5.4	159	162	.....	1,160	9,130	3,133	4,508	.....	.....	.....	1,650	3,740
5.6	193	180	.....	1,270	9,770	3,355	4,872	.....	.....	.....	1,780	4,080
5.8	229	198	.....	1,380	10,430	3,577	5,236	.....	.....	.....	1,920	4,420
6.0	265	216	.....	1,500	11,110	3,799	5,600	.....	.....	.....	2,060	4,760
6.2	303	235	.....	1,625	11,790	4,021	.....	.....	.....	.....	2,200	5,100
6.4	341	255	.....	1,755	12,470	4,243	.....	.....	.....	.....	2,340	5,440
6.6	379	275	.....	1,890	13,150	4,465	.....	.....	.....	.....	2,480	5,780
6.8	417	295	.....	2,030	13,830	4,687	.....	.....	.....	.....	2,620	6,120
7.0	455	315	.....	2,175	14,510	4,909	.....	.....	.....	.....	2,760	6,460
7.2	493	335	.....	2,325	15,200	.....	.....	.....	.....	.....	2,900	6,800
7.4	531	357	.....	2,480	15,900	.....	.....	.....	.....	.....	3,043	7,140
7.6	570	379	.....	2,640	16,600	.....	.....	.....	.....	.....	3,188	7,480
7.8	610	401	.....	2,800	17,300	.....	.....	.....	.....	.....	3,334	7,820
8.0	650	425	.....	2,970	18,000	.....	.....	.....	.....	.....	3,480	8,180
8.5	755	487	.....	3,400	19,750	.....	.....	.....	.....	.....	3,850	9,130
9.0	860	550	.....	3,850	21,500	.....	.....	.....	.....	.....	4,225	10,080
9.5	967	621	.....	4,315	23,250	.....	.....	.....	.....	.....	4,600	11,030
10.0	1,084	696	.....	4,800	25,000	.....	.....	.....	.....	.....	5,000	12,000
11.0	1,327	865	.....	5,870	.....	.....	.....	.....	.....	.....	5,400	14,000
12.0	1,604	1,050	.....	7,000	.....	.....	.....	.....	.....	.....	6,619	16,100
13.0	1,900	1,260	.....	8,240	.....	.....	.....	.....	.....	.....	7,458	18,350
14.0	2,204	1,485	.....	9,860	.....	.....	.....	.....	.....	.....	8,300	.....
15.0	2,528	1,710	.....	12,030	.....	.....	.....	.....	.....	.....	9,150	.....
16.0	2,884	1,960	.....	14,280	.....	.....	.....	.....	.....	.....	10,100	.....
17.0	3,267	2,235	.....	16,530	.....	.....	.....	.....	.....	.....	11,150	.....
18.0	3,681	2,530	.....	18,780	.....	.....	.....	.....	.....	.....	12,300	.....
20.0	.....	3,130	.....	23,280	.....	.....	.....	.....	.....	.....	14,700	.....
25.0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	21,300	.....
30.0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	28,300	.....
35.0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	35,450	.....

[a] Applicable from May 1 to December 31, 1901. Use table for 1900 from January 1 to April 30, 1902.

Rating tables of stations in Texas, Colorado, New Mexico, Wyoming, and Utah.

[Discharge in second-feet.]

Gage height, in feet.	Brazos River at Waco, Tex.	Colorado River at Austin, Tex.	Rio Grande near Del Norte, Colo.	Rio Grande at Cenicero, Colo.	Rio Grande at Embudo, N. Mex.	Rio Grande at Embudo, N. Mex.	Rio Grande at Rio Grande, N. Mex.	Rio Grande at Rio Grande, N. Mex.	Green River at Greenriver, Wyo.	Ashley Creek near Vernal, Utah.	Uinta River near Whiterocks, Utah.	Whiterocks River near Whiterocks, Utah.
0.0					(a)	(b)	(c)	(d)	85			
0.2									190			
0.4									315	32		
0.6									460	43		
0.8				22					625	72	134	53
1.0				43					805	111	182	79
1.2			140	79					1,015	152	239	114
1.4		100	258	142					1,235	198	331	164
1.6		210	384	236					1,470	250	463	231
1.8		380	518	414					1,720	309	640	316
2.0		580	660	594					1,980	369	846	404
2.2	61	825	812	774					2,280	429	1,056	492
2.4	95	1,190	978	954					2,655	492	1,266	580
2.6	145	1,908	1,149	1,134					3,130	558		668
2.8	221	2,704	1,329	1,314					3,705	626		756
3.0	315	3,500	1,522	1,494					4,375	694		844
3.2	415	4,296	1,734	1,674					5,090	762		932
3.4	515	5,092	1,968	1,854					5,822	830		1,020
3.6	616	5,888	2,216	2,034					6,554	898		1,108
3.8	721	6,684	2,478	2,214					7,286	966		
4.0	830	7,480	2,754	2,394					8,018	1,034		
4.2	962	8,276	3,054	2,574					8,750	1,102		
4.4	1,126	9,072	3,354	2,754				230	9,482	1,170		
4.6	1,322	9,868	3,654	2,934			180	300	10,214			
4.8	1,550	10,664	3,954	3,114			280	380	10,946			
5.0	1,800	11,460	4,254	3,294			390	480	11,678			
5.2	2,056	12,256	4,554				530	580	12,410			
5.4	2,315	13,052	4,854				690	710				
5.6	2,575	13,848	5,154				850	850				
5.8	2,836	14,644	5,454				1,020	1,020				
6.0	3,100	15,440	5,754				1,190	1,190				
6.2	3,365	16,236					1,360	1,360				
6.4	3,650	17,032					1,530	1,530				
6.6	3,955	17,828					1,700	1,700				
6.8	4,280	18,624					1,870	1,870				
7.0	4,625	19,420			200		2,040	2,040				
7.2	4,990	20,216			240	260	2,210					
7.4	5,375	21,012			280	340	2,380					
7.6	5,780	21,808			350	420	2,580					
7.8	6,205	22,604			450	500	2,810					
8.0	6,650	23,400			560	590	3,060					
8.2	7,115	24,196			680	690	3,320					
8.4	7,600	24,992			800	800	3,580					
8.6	8,105	25,788			920	920	3,860					
8.8	8,630	26,584			1,040	1,040	4,140					
9.0	9,180	27,380			1,160	1,160	4,420					
9.5	10,730	29,370			1,470	1,470	5,380					
10.0	12,530	31,360			2,020	2,020	6,630					
10.5	14,510				2,940							
11.0	16,750				4,200							
11.5	19,530				5,575							
12.0	22,310				6,950							
13.0	27,870											
14.0	33,430											
16.0	44,550											
18.0	55,670											

[a] Applicable from January 1 to July 27, 1901.
[b] Applicable from July 28 to December 31, 1901.
[c] Applicable from January 1 to June 29, 1901.
[d] Applicable from June 30 to December 31, 1901.

Rating tables for stations in Utah, Colorado, and Nevada.

[Discharge in second-feet.]

Gage height, in feet.	Uinta River at Fort Duchesne, Utah.	Uinta River at Ouray School, Utah.	Lake Creek, Utah, near mouth.	Duchesne River at Price road bridge, Utah.	Grand River at Glenwood Springs, Colo.	Gunnison River at Iola, Colo.	Dolores River at Dolores, Colo.	Los Pinos River at Ignacio, Colo.	Florida River near Durango, Colo.	Animas River at Durango, Colo.	Humboldt River near Elko, Nev.	South Fork of Humboldt River at Mason's ranch, Nevada.
0.0		46										
0.2		71										
0.4		100										7
0.6		133										24
0.8		171							11			47
1.0		215							19			74
1.2		265							30			105
1.4		321							45			141
1.6		383							74		0.5	182
1.8		457	85						122		7	227
2.0		547	124			300		25	170		22	276
2.2		653	189			426		43	222		43	327
2.4	57	780	268			574	20	73	274		70	382
2.6	97	953	351			764	37	125	326		104	439
2.8	152	1,145	438		570	992	82	208	378		144	499
3.0	218	1,360	531		650	1,252	164	315	430		190	559
3.2	295	1,580	629		755	1,538	280	435	482		240	619
3.4	392	1,800	732		870	1,835	412	555	534		292	679
3.6	525	2,020	836		1,005	2,137	555	675			346	740
3.8	735	2,240	942		1,160	2,442	700	795			402	801
4.0	1,025	2,460	1,051		1,350	2,750	847	918			461	862
4.2	1,520	2,680	1,163		1,570	3,062	1,001	1,042			525	922
4.4	2,120	2,900	1,280		1,810	3,374	1,160	1,166			594	983
4.6	2,720	3,120	1,402		2,090	3,686	1,327	1,290			667	1,045
4.8	3,320		1,532		2,430	3,998	1,506	1,414			743	1,106
5.0	3,920		1,670	217	2,815	4,310	1,686	1,538			822	1,168
5.2			1,820	278	3,245	4,622		1,662			903	1,230
5.4			1,980	355	3,770	4,934					988	1,292
5.6			2,144	473	4,420	7,246					1,076	1,354
5.8			2,314	630	5,080						1,166	1,416
6.0			2,488	790	5,740						1,257	1,478
6.2			2,665	950	6,420					122	1,352	
6.4			2,845	1,110	7,100					168	1,449	
6.6				1,280	7,800					243	1,550	
6.8				1,466	8,520					337	1,655	
7.0				1,671	9,250					438	1,763	
7.2				1,907	10,000					544	1,873	
7.4				2,178	10,765					655	1,986	
7.6				2,496	11,540					781	2,101	
7.8				2,862	12,345					925	2,218	
8.0				3,276	13,155					1,080	2,339	
8.2				3,735	13,970					1,246		
8.4				4,203	14,800					1,424		
8.6				4,671	15,660					1,610		
8.8				5,141	16,520					1,805		
9.0				5,613	17,390					2,055		
9.2				6,085	18,300					2,319		
9.4				6,557	19,240					2,583		
9.6					20,180					2,847		
9.8					21,150					3,111		
10.0					22,140					3,375		
10.2					23,150							

Rating tables for stations in Nevada and California.

[Discharge in second-feet.]

Gage height, in feet.	Humboldt River near Golconda, Nev.	Humboldt River near Oreana, Nev.	East Fork of Carson River near Gardnerville, Nev.	East Fork of Carson River near Gardnerville, Nev.	West Fork of Carson River at Woodfords, Cal.	Carson River near Empire, Nev.	Carson River near Empire, Nev.	Truckee River at Tahoe, Cal.	Truckee River at Nevada-California State line.	Truckee River at Vista, Nev.	Steamboat Creek at Steamboat Springs, Nevada.	Susan River near Susanville, Cal.
−0.2	0.5	10	([a])	([b])	.....	([c])	([d])	15	.....	.....	([e])	.....
0.0	2.5	17	.....	.....	.....	.....	.....	25	.....	.....	.....	.....
0.2	8	26	.....	.....	.....	.....	.....	36	.....	.....	.....	.....
0.4	14	38	.....	.....	.....	.....	32	51	.....	.....	.....	.....
0.6	22	52	.....	.....	.....	.....	49	72	.....	.....	3	.....
0.8	30	69	.....	.....	.....	.....	70	100	.....	.....	7	.....
1.0	40	88	.....	.....	.....	.....	96	136	.....	.....	11	.....
1.2	52	110	.....	.....	.....	.....	128	178	.....	.....	17	.....
1.4	66	135	.....	.....	.....	.....	167	225	268	.....	25	.....
1.6	82	167	.....	.....	.....	.....	213	279	319	.....	34	.....
1.8	99	205	11	.....	.....	.....	267	339	383	.....	44	.....
2.0	118	249	17	.....	15	.....	329	407	463	110	56	.....
2.2	139	301	25	.....	26	.....	399	486	559	185	68	.....
2.4	162	361	35	.....	41	46	478	580	671	274	.....	11
2.6	188	430	48	.....	60	113	569	.....	795	370	.....	15
2.8	217	511	65	.....	83	293	672	.....	924	467	.....	22
3.0	248	604	86	35	112	496	788	.....	1,055	566	.....	30
3.2	282	712	115	57	147	715	924	.....	1,194	668	.....	44
3.4	317	839	157	85	187	943	1,084	.....	1,345	773	.....	60
3.6	352	986	219	122	232	1,177	1,267	.....	1,508	882	.....	90
3.8	395	1,152	313	179	281	1,427	1,473	.....	1,683	995	.....	134
4.0	438	1,331	438	271	336	1,700	1,708	.....	1,870	1,110	.....	180
4.2	485	1,519	575	401	396	1,988	1,988	.....	2,069	1,227	.....	248
4.4	533	1,716	715	550	461	2,304	2,304	.....	2,280	1,348	.....	316
4.6	583	1,930	856	.....	533	.....	2,639	.....	2,505	1,473	.....	390
4.8	635	2,175	998	.....	613	.....	2,985	.....	2,745	1,601	.....	470
5.0	688	2,459	1,141	.....	700	.....	3,339	.....	3,002	1,733	.....	550
5.2	742	.....	1,286	.....	794	.....	3,700	.....	3,283	1,871	.....	630
5.4	799	.....	1,435	.....	896	.....	.....	.....	3,596	2,015	.....	710
5.6	860	.....	1,590	.....	.....	.....	.....	.....	3,953	2,168	.....	790
5.8	926	.....	1,752	.....	.....	.....	.....	.....	4,370	2,338	.....	870
6.0	997	.....	1,922	.....	.....	.....	.....	.....	.....	2,537	.....	950
6.2	1,075	.....	2,094	.....	.....	.....	.....	.....	.....	2,780	.....	1,030
6.4	1,155	.....	2,267	.....	.....	.....	.....	.....	.....	3,079	.....	1,110
6.6	1,240	.....	2,442	.....	.....	.....	.....	.....	.....	3,438	.....	1,190
6.8	1,340	.....	2,619	.....	.....	.....	.....	.....	.....	3,857	.....	1,270
7.0	1,450	.....	2,798	.....	.....	.....	.....	.....	.....	4,336	.....	1,350
7.2	1,565	.....	2,979	.....	.....	.....	.....	.....	.....	.....	.....	.....
7.4	1,695	.....	3,162	.....	.....	.....	.....	.....	.....	.....	.....	.....
7.6	1,825	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
7.8	1,965	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
8.0	2,105	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
8.2	2,245	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
8.4	2,385	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
8.6	2,525	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
8.8	2,665	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
9.0	2,805	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
9.2	2,945	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

[a] Applicable from October 17, 1900, to August 2, 1901, and from December 5, 1901, to December 31, 1901.
[b] Applicable from August 3, 1901, to December 4, 1901.
[c] Applicable from October 21, 1900, to February 18, 1901.
[d] Applicable from February 19, 1901, to December 31, 1901.
[e] Applicable from January 4 to June 30, 1901.

Rating tables for stations in Idaho and Utah.

[Discharge in second-feet.]

Gage height in feet.	Bear River at Battle Creek, Idaho.	Logan River at Logan, Utah.	Blacksmith Fork at Hyrum, Utah.	Bear River near Collinston, Utah.	Weber River near Uinta, Utah.	Spanish Fork near Mapleton, Utah.	Provo River near Provo, Utah.	American Fork near American Fork, Utah.	San Pitch River near Gunnison, Utah.	Sevier River near Gunnison, Utah.	Boise River near Boise, Idaho.	Weiser River near Weiser, Idaho.
0.2												39
0.4								43		6		71
0.6				300				99		17	800	105
0.8				400				186		33	920	150
1.0				520				306		49	1,030	215
1.2				690	110			440		69	1,200	290
1.4	434			870	210						1,350	375
1.6	522			1,070	320						1,510	470
1.8	640			1,270	440	36			15		1,690	585
2.0	770			1,470	560	75			37		1,870	720
2.2	912			1,670	684	119			65		2,070	875
2.4	1,070	137		1,880	816	164			95		2,300	1,050
2.6	1,250	167		2,100	955	212					2,570	1,235
2.8	1,450	213	108	2,330	1,095	260					2,880	1,425
3.0	1,650	275	120	2,570	1,235	308					3,260	1,625
3.2	1,854	350	147	2,820	1,375	359					3,708	1,840
3.4	2,058	450	241	3,080	1,515						4,156	2,075
3.6	2,262	574	347	3,340	1,655						4,604	2,325
3.8	2,466	706		3,600	1,795						5,052	2,585
4.0	2,670	850		3,860	1,935						5,500	2,855
4.2	2,874	1,015		4,140	2,075		240				5,948	3,125
4.4		1,185		4,420	2,215		279				6,396	3,395
4.6		1,355		4,700	2,355		327				6,844	3,665
4.8				5,000			381				7,292	3,935
5.0				5,300			445				7,740	4,205
5.2							536				8,188	4,475
5.4							645				8,636	4,745
5.6							788				9,084	5,015
5.8							962				9,532	5,285
6.0							1,136				9,980	5,555
6.2							1,310				10,428	5,825
6.4							1,484				10,876	6,095
6.6							1,658				11,324	6,365
6.8							1,832				11,772	6,635
7.0							2,006				12,220	
7.2											12,668	

Rating tables for stations in Montana, Washington, Oregon, and California.

[Discharge in second-feet.]

Gage height, in feet.	Blackfoot River near Bonner, Mont.	Missoula River at Missoula, Mont.	Spokane River at Spokane, Wash.	Naches River near North Yakima, Wash.	Yakima River at Union Gap, Wash.	Yakima River at Kiona, Wash.	Palouse River near Hooper, Wash.	Umatilla River at Gibbon, Oreg.	Elwha River at McDonald, Wash.	Kalawa River near Forks, Wash.	Soleduck River near Quillayute, Wash.	Sacramento River at Jellys Ferry, Cal.
0.0	.....	.....	.....	.....	.....	.....	.....	56	.....	71	.....	.....
0.2	400	.....	.....	.....	.....	.....	.....	74	.....	105	.....	.....
0.4	500	.....	.....	.....	.....	.....	.....	92	.....	147	.....	.....
0.6	620	.....	.....	.....	.....	.....	4	124	.....	194	.....	.....
0.8	760	.....	.....	.....	.....	.....	8	172	.....	246	.....	.....
1.0	900	.....	1,341	.....	.....	.....	12	233	.....	300	.....	.....
1.2	1,060	.....	1,611	.....	.....	.....	16	298	.....	356	.....	.....
1.4	1,220	.....	1,897	.....	.....	.....	20	372	460	416	.....	.....
1.6	1,400	.....	2,199	.....	.....	.....	26	454	490	480	.....	.....
1.8	1,580	.....	2,517	.....	.....	.....	40	544	565	548	.....	.....
2.0	1,760	.....	2,851	.....	.....	.....	61	642	645	620	.....	.....
2.2	1,980	.....	3,201	.....	.....	.....	86	748	725	698	.....	.....
2.4	2,220	.....	3,566	.....	.....	.....	115	862	820	784	.....	.....
2.6	2,500	.....	3,946	.....	.....	.....	148	984	929	882	.....	.....
2.8	2,800	.....	4,340	.....	.....	.....	185	1,114	1,042	995	155	.....
3.0	3,100	.....	4,749	.....	.....	415	226	1,252	1,160	1,118	201	.....
3.2	3,450	1,080	5,172	.....	.....	465	271	1,398	1,300	1,250	260	.....
3.4	3,800	1,300	5,609	.....	.....	495	320	1,552	1,460	1,389	325	.....
3.6	4,160	1,560	6,059	.....	.....	566	377	1,714	1,630	1,532	400	.....
3.8	4,592	1,820	6,523	.....	.....	663	446	1,884	1,900	1,679	483	.....
4.0	5,106	2,100	7,000	.....	650	780	525	2,061	2,320	1,830	580	2,400
4.2	5,620	2,430	7,489	.....	850	917	620	2,245	2,788	1,982	680	2,670
4.4	6,134	2,760	7,990	.....	1,050	1,074	735	2,435	3,256	2,134	780	2,970
4.6	6,648	3,100	8,503	.....	1,250	1,252	866	2,633	3,724	2,286	890	3,290
4.8	7,162	3,500	9,028	.....	1,450	1,468	998	2,839	4,192	2,438	1,022	3,630
5.0	7,672	3,900	9,565	350	1,700	1,705	1,130	3,052	4,660	2,590	1,180	3,980
5.2	8,190	4,400	10,114	390	1,950	1,962	1,262	3,272	5,128	2,742	1,350	4,360
5.4	8,704	4,900	10,673	470	2,250	2,240	1,394	3,498	5,596	2,894	1,540	4,760
5.6	9,218	5,400	11,243	590	2,600	2,534	1,526	3,730	6,064	3,046	1,780	5,170
5.8	9,732	6,000	11,824	750	3,000	2,842	1,658	3,970	6,532	3,198	2,050	5,590
6.0	10,246	6,600	12,416	910	3,500	3,160	1,790	4,217	7,000	3,350	2,320	6,030
6.2	10,760	7,300	13,019	1,090	4,000	3,490	1,922	.....	7,468	3,502	2,590	6,500
6.4	11,274	8,000	13,631	1,300	4,500	3,834	2,054	.....	7,936	3,654	2,860	7,000
6.6	11,788	8,700	14,253	1,550	5,100	4,190	2,186	.....	.....	3,806	3,130	7,530
6.8	12,302	9,400	14,885	1,840	5,700	4,556	2,318	.....	.....	3,958	3,400	8,070
7.0	12,816	10,200	15,525	2,170	6,300	4,935	2,450	.....	.....	4,110	3,670	8,630
7.2	.....	11,000	16,173	2,570	6,900	5,326	2,582	.....	.....	.....	3,940	9,200
7.4	.....	11,800	16,829	3,010	7,600	5,730	2,714	.....	.....	.....	4,210	9,800
7.6	.....	12,700	17,493	3,500	8,300	6,143	2,846	.....	.....	.....	4,480	10,400
7.8	.....	13,700	18,165	4,030	9,000	6,565	2,978	.....	.....	.....	4,750	11,000
8.0	.....	14,700	18,845	4,600	9,700	6,995	3,110	.....	.....	.....	5,020	11,600
8.2	.....	15,700	19,533	5,200	10,400	7,436	3,242	.....	.....	.....	5,290	12,200
8.4	.....	16,700	20,228	5,800	11,100	7,890	3,374	.....	.....	.....	5,560	12,800
8.6	.....	17,800	20,928	6,400	11,800	8,354	3,506	.....	.....	.....	5,830	13,400
8.8	.....	19,000	21,636	7,000	12,500	8,830	3,638	.....	.....	.....	6,100	14,000
9.0	.....	20,200	22,351	7,600	13,200	9,320	3,770	.....	.....	.....	6,370	14,600
9.5	.....	24,000	24,165	9,100	14,950	10,614	4,100	.....	.....	.....	7,045	16,100
10.0	.....	.....	26,012	.....	16,700	12,045	4,430	.....	.....	.....	7,720	17,600
11.0	.....	.....	29,787	.....	20,200	15,045	5,090	.....	.....	.....	9,070	20,800
12.0	.....	.....	33,653	.....	23,700	18,045	5,750	.....	.....	.....	10,420	24,400
13.0	.....	.....	.....	.....	.....	21,045	6,410	.....	.....	.....	11,770	28,400
14.0	.....	.....	.....	.....	.....	24,045	7,070	.....	.....	.....	.....	32,400
15.0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	36,800
20.0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	64,200
25.0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	96,600
30.0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	129,600
35.0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	162,600

Rating tables for stations in California.

[Discharge in second-feet.]

Gage height, in feet.	Stony Creek near Fruto, Cal.	Cache Creek near Lower Lake, Cal.	Mokelumne River at Electra, Cal.	Tuolumne River at Lagrange, Cal.	Merced River above Merced Falls, Cal.	San Joaquin River at Herndon, Cal.	King River near Red Mountain, Cal.	San Antonio Creek near Jolon, Cal.	San Lorenzo Creek near King City, Cal.	Arroyo Seco near Piney, Cal.	Salinas River near Salinas, Cal.	Tule River near Portersville, Cal.
1.0		10										18
1.2		22										30
1.4		40										51
1.6		62										78
1.8		86										109
2.0		117										144
2.2		155				340				65		183
2.4		205				380				75		226
2.6		255				430				85		273
2.8		315				500				95		324
3.0	0	380				600				105		379
3.2	5	450				730				160		440
3.4	15	530		7		900				240	20	515
3.6	35	615	330	25		1,100	180			400	40	615
3.8	62	705	410	55		1,315	250			610	65	770
4.0	97	805	510	115		1,550	320	39	0	830	110	
4.2	140	920	610	200		1,800	400	64	6	1,050	180	
4.4	195	1,040	710	300		2,060	480	110	13	1,270	280	
4.6	260	1,175	830	410		2,340	572	183	22	1,490	380	
4.8	340	1,330	950	560		2,630	676	280	32	1,710	480	
5.0	435	1,520	1,070	750		2,950	780	400	46	1,930	600	
5.2	555	1,720	1,200	950		3,280	910	530	62	2,150	730	
5.4	725	1,920	1,350	1,180		3,620	1,040	670	80	2,380	900	
5.6	925	2,120	2,520	1,440		3,985	1,170	820	125	2,620	1,100	
5.8	1,125	2,320	1,720	1,740		4,370	1,310	1,010	175	2,860	1,300	
6.0	1,325	2,520	1,960	2,080		4,775	1,450	1,210	240	3,100	1,500	
6.2	1,540		2,220	2,490		5,190	1,642	1,440	350	3,350	1,715	
6.4	1,785		2,480	2,900		5,625	1,834	1,700	460	3,620	1,950	
6.6	2,060		2,740	3,345		6,080	2,034	1,980	600	3,900	2,205	
6.8	2,390		3,020	3,830		6,570	2,242	2,280	720	4,200	2,480	
7.0	2,790		3,300	4,320		7,090	2,450	2,600	870	4,500	2,790	
7.2	3,224		3,580	4,900		7,618	2,718	2,940	1,040		3,150	
7.4	3,658		3,860	5,500		8,146	2,986	3,300	1,200		3,590	
7.6	4,092		4,200	6,120		8,674	3,280	3,700	1,400		4,110	
7.8	4,526		4,600	6,760		9,202	3,600	4,200	1,610		4,710	
8.0	4,960		5,000	7,400		9,730	3,920	4,700	1,820		5,400	
8.2	5,394		5,420	8,040	130	10,262	4,300		2,052		6,110	
8.4	5,828		5,860	8,680	170	10,794	4,680		2,284		6,820	
8.6	6,262		6,320	9,320	220	11,328	5,096		2,540		7,530	
8.8	6,696		6,790	9,960	280	11,864	5,548		2,820		8,240	
9.0	7,130		7,270	10,600	330	12,400	6,000		3,100		8,950	
9.2	7,564		7,770		460	12,940	6,520		3,420		9,680	
9.4	7,998		8,290		580	13,480	7,040		3,740		10,410	
9.6	8,432		8,830		730	14,022	7,600		4,080		11,140	
9.8	8,866		9,390		900	14,566	8,220		4,440		11,870	
10.0	9,300		9,980		1,090	15,110	8,900		4,800		12,600	
10.2	9,734		10,590		1,310	15,662	9,610		5,160		13,350	
10.4	10,168		11,220		1,550	16,214	10,400		5,520		14,100	
10.6	10,602		11,870		1,810	16,766	11,300		5,920		14,850	
10.8	11,036		12,530		2,090	17,318	12,250		6,360		15,600	
11.0	11,470		13,210		2,390	17,870	13,240		6,800		16,350	
11.5	12,555				3,200	19,300	16,040		7,900		18,225	
12.0	13,640				4,140	20,780	19,230		9,300		20,100	
12.5	14,725				5,230				10,600		21,975	
13.0	15,813				6,510						23,850	
14.0	17,980				9,450						27,600	
15.0											31,350	
16.0											35,100	

INDEX.

A.

Page.

Albion, Nebr., hydrographic work at ... 43
Alturas, Cal., rainfall at ... 169
American Fork, Utah, hydrographic work near ... 124
American Fork near American Fork, Utah, measurements of ... 124
rating table for ... 176
American River at and above Riverton, Cal., measurements of ... 167
Amity Canal head gates, Colorado, hydrographic work at ... 53-54
Animas River at Durango, Colo., rating table for ... 174
Appleby, J. F., measurements by ... 101, 103
Arkansas River, measurements of, at Amity Canal head gates, Colorado ... 53-54
measurements of, at Granite, Colo ... 47
at Hutchinson, Kans ... 56
at Prowers, Colo ... 53
at Pueblo, Colo ... 49-50
at Salida, Colo ... 47-48
near Barton, Colo ... 54-55
near Canyon, Colo ... 48-49
near Granada, Colo ... 54
near La Junta, Colo ... 52
near Nepesta, Colo ... 50-51
near Rockyford, Colo ... 51-52
rating table for, at Prowers, Colo ... 172
at Pueblo, Colo ... 172
at Hutchinson, Kans ... 172
near Canyon, Colo ... 172
near Nepesta, Colo ... 172
Arkansas River Basin, measurements in ... 47-58
Arkins, Colo., hydrographic work near ... 36
rating table for Big Thompson Creek near ... 171
Arlington, Nebr., hydrographic work near ... 40-41
Arnold, S., measurements by ... 134, 136
Arroyo Seco, measurements of, near Pasadena, Cal ... 161
measurements of, near Pettitt's ranch ... 167
near Piney, Cal ... 156
rating table for, near Piney, Cal ... 178
Ashley Creek near Vernal, Utah, measurements of ... 83-84
rating table for ... 173
Austin, Tex., hydrographic work at ... 64
rating table for Colorado River at ... 173
Axial, Colo., hydrographic work at ... 98
Azusa, Cal., hydrographic work near ... 161
rainfall near, at Follows Camp ... 169

B.

Page.

Babb, C. C., work done by ... 14, 15, 23, 84, 85, 98, 88, 122, 133, 124
Baker, J. S., work done by ... 17, 18, 21, 23, 131, 132
Bakersfield, Cal., hydrographic work near ... 158-159
rainfall near, at Tejon ranch and Fort Tejon ... 169
Banning, J. A., observations by ... 30
Bantel, E. C. H., measurement by ... 63
Barber, Miss B., aid by ... 32
Barton, Colo., hydrographic work near ... 54-55
Bassell, B., measurements by ... 145
Battlecreek, Idaho, hydrographic work at ... 117
Battle Creek, Idaho, rating table for ... 176
Beach, C. W., measurements by ... 50, 51, 52, 53, 55
Bear Creek near Morrison, Colo., measurements of ... 31
rating table for ... 171
Bear River, measurements of, at Battlecreek, Idaho ... 117
measurements of, near Collinston, Utah ... 120, 129
rating table for, at Battlecreek, Idaho ... 176
near Collinston, Utah ... 176
Beaver River, measurements of at Albion, Nebr ... 43
measurements of at Geneva, Nebr ... 43
Beers, E., aid by ... 28
Beers, W. D., measurements by ... 119
Bennett, S. G., work done by ... 154, 157
Big Blue River at Wymore, Nebr., measurements of ... 43
Bighorn River near Thermopolis, Wyo., measurements of ... 23
rating table for ... 170
Big Sioux River, measurements of ... 24-25
rating table for ... 170
Big Thompson Creek near Arkins, Colo., measurements of ... 36
rating table for ... 171
Birdwood Creek, Nebraska, measurements of ... 43
Birge, D. L., aid by ... 53
Bitterroot River at Missoula, Mont., measurements of ... 131-132
Blackfoot River near Bonner, Mont., measurements of ... 130
rating table for ... 177
Blacksmith Fork at Hyrum, Utah, measurements of ... 119-120
rating table for ... 176

Page.
Blue River, measurements of, at Kremmling, Colo ... 98
measurements of, near Manhattan, Kans ... 46
rating table for, near Manhattan, Kans ... 172
Boise, Idaho, hydrographic work near ... 128
rating table for Boise River near ... 176
Boise River, seepage into, measurements to ascertain ... 129
measurements of, near Boise, Idaho ... 128
rating table for, near Boise, Idaho ... 176
Boise Valley, Idaho, miscellaneous measurements in ... 129
Bonner, Mont., hydrographic work near ... 130
rating table for Blackfoot River near ... 177
Bosque River, Texas, character and features of ... 59
Boulder, Colo., hydrographic work near ... 33-34
rating table for Boulder Creek near ... 171
Boulder Creek near Boulder Colo., measurements of ... 33-34
rating table for ... 171
Bozeman, Mont., hydrographic work at ... 23
Bozeman Creek near Bozeman, Mont., measurements of ... 23
Branch, L. V., measurements by ... 88
Brazos River at Waco, Tex., measurements of ... 58-59
rating table for ... 173
Briscoe River, California, measurements of ... 167
Bruneau River near Grandview, Idaho, measurements of ... 127
Bryson, Cal., hydrographic work near ... 154
Buckley, Wash., hydrographic work near ... 138
Burbank, Cal., rainfall near, at Magic Hill No. 1 ... 169
Burney River, California, measurements of ... 167
Burrows, T. J., aid by ... 50

C.

Cache Creek near Lower Lake, Cal., measurements of ... 144-145
rating table for ... 178
Cache la Poudre River, measurements of, at Greeley, Colo ... 55
measurements of, near Fort Collins, Colo ... 36-37
Cajon, Cal., rainfall near, at Glen Ranch ... 169
California, micellaneous measurements in ... 167
California (southern), rainfall and rainfall stations in, table showing ... 168-169
Cameron, Tex., hydrographic work near ... 61
Campbell, C. N., measurements by ... 59, 64
Campo, Cal., rainfall at ... 169
Canyon, Colo., hydrographic work near ... 48-49
rating table for ... 172
Carpenter, L. G., aid by ... 36
Carrizo Springs, Texas, wells near ... 63
Carrizo Springs Creek, Texas, measurement of ... 63
Carrizo Springs mineral water, analysis of ... 63
Carson River near Empire, Nev., measurements of ... 110-111
rating table for ... 175
Carson River (east fork) near Gardnerville, Nev., measurements of ... 108-109
rating table for ... 175
Carson River (west fork) at Woodfords, Cal., measurements of ... 109-110
rating table for ... 175
Cedaredge, Colo., hydrographic work at ... 98
Cedar River at Fullerton, Nebr., measurements of ... 43
Cenicero, Colo., hydrographic work at ... 65-66
rating table for Rio Grande at ... 173
Channel, C. B., aid by ... 43
Chappell, F., aid by ... 51
Cheesman, Colo., hydrographic work at ... 29
Cherry Creek near Redbluff, Mont., measurements of ... 19
Cherry River at Eleanor trail crossing, California, measurements of ... 148
Church, S. D., measurements by ... 72-75
Cimarron, Colo., hydrographic work at ... 55
Cimarron River at Cimarron, Colo., measurements of ... 55
Clallam River near East Clallam, Wash., measurements of ... 142
Clapp, W. B., measurements by ... 161
Clear Creek at Forkscreek, Colo., measurements of ... 31-32
rating table for ... 171
Cockins, W. W., jr., stations established by ... 154, 155, 156
Colbran, Colo., hydrographic work at ... 98
Cole, B., station established by ... 143
Collinston, Utah, hydrographic work near ... 120-121
rating table for Bear River at ... 176
Colorado, miscellaneous measurements in ... 55
Colorado River, measurements of, at Austin, Tex ... 64
measurements of, at Yuma, Ariz ... 104
rating table for, at Austin, Tex ... 173
Colorado River Basin, measurements in ... 82-104
miscellaneous measurements in ... 98
Columbia River Basin, measurements in ... 126-138
Columbus, Nebr., hydrographic work near ... 38-39
Commissioner of Indian Affairs, station established at request of ... 95
Concho River, Texas, course, character, and discharge of and irrigation from ... 61-62
Coulterville, Cal., rainfall at ... 169
Crafton Water Company, aid by ... 166
Craig, Colo., hydrographic work at ... 90, 91, 98
Crane, A. B., measurements by ... 24
Crookston, Minn., hydrographic work at ... 10-11
Crow Creek near Radersburg, Mont., measurements of ... 21-22

Page.
Cub River at Franklin, Idaho, measurements of 148
Cucamonga Creek, California, measurements of 167
Culbertson, Nebr., hydrographic work at 43
Cunningham, P. D., measurements by 70
Cuyamaca, Cal., rainfall at 169

D.

Davis, A. P., work done by 19, 99
Deep Creek, Utah, measurements of 85
Del Norte, Colo., hydrographic work near 65
rating table for Rio Grande near 173
Delta, Cal., rainfall at 169
Delta, Colo., hydrographic work at and near 98
Denis, W. H., aid by 76
Denver, Colo., hydrographic work at 30
rating table for South Platte River at 171
Denver and Rio Grande Railroad Company, station established at request of 92
Descanso, Cal., rainfall at 169
Devils Lake, N. Dak., hydrographic work at 14
measurements of 14
Devils River at Devilsriver, Tex., measurements of 79
Devilsriver, Tex., hydrographic work at and near 79–81
Dewey, E. P., measurements by 161
Dickson, L. H., aid by 34
Dillard, J. D., and Greet, W. D., measurements by 75, 78, 79, 80, 81
Dils, N. C., measurements by 126, 128, 129
Dobson, F., measurements by 28
Dolores, Colo., hydrographic work at 95, 98
rating table for Dolores River at 174
Dolores River at Dolores, Colo., measurements of 95
measurements of, at Rico, Colo 98
rating table for 174
Duchesne River at Price road bridge, Utah, measurements of 88–89
rating table for 174
Dungeness, Wash., hydrographic work at 138–139
Dungeness River at Dungeness, Wash., measurements of 138–139
Dunkley, Colo., hydrographic work at 98
Dunsmuir, Cal., rainfall at 169
Durango, Colo., hydrographic work at and near 96–97
rating table for Florida and Animas rivers near 174

E.

Eagle Pass, Tex., hydrographic work near 81–82
East Clallam, Wash., hydrographic work near 142
Eleanor Creek at Eleanor trail crossing, California, measurements of 147

Page.
Eleanor trail crossing, California, hydrographic work at 147–148
Electra, Cal., hydrographic work at 145–146
rating table for Mokelumne River at 158
Elk Creek, Cal., rainfall near, at Julians 169
Elk Head Creek at Craig, Colo., measurements of 98
Elkhorn River, measurements of, near Arlington, Nebr. 40–41
measurements of, near Norfolk, Nebr 40
rating table for, near Norfolk, Nebr. 171
Elkhorn River, north fork of, at Norfork, Nebr., measurements of 43
Elko, Nev., hydrographic work near 104–105
rating table for Humboldt River near 174
Ellsworth, Kans., hydrographic work at 45
rating table for Smoky Hill River at 172
El Paso, Tex., hydrographic work near 70
Elwha River at McDonald, Wash., measurements of 139–140
rating table for 177
Embudo, N. Mex., hydrographic work at 66–67
rating table for Rio Grande at 173
Emerson, Manitoba, hydrographic work at 13–14
Empire, Nev., hydrographic work near 110–111
rating table for Carson River near 175

F.

Fall River, California, measurements of 167
Fargo, N. Dak., hydrographic work at 9–10
Feather River, California, measurements of 167
Fellows, A. L., work done by 31, 38, 47, 48, 49, 50, 51, 52, 53, 55, 65, 90, 91, 92, 93, 94, 95, 96, 97, 98
Fellows, A. L., and Beach, C. W., station established by 50
Field, J. E., measurements by 32, 33, 34, 36, 38, 48, 49, 50, 51, 52, 53, 55
Fish Creek at Dunkley, Colo., measurements of 98
Flathead Lake at Polson, Mont., measurements of 132
Florida River near Durango, Colo., measurements of 96–97
rating table for 174
Follett, W. W., measurements by 70
Follows Camp, Cal., rainfall at 169
Forks, Wash., hydrographic work near 140–141
rating table for Kalawa River near 177
Forkscreek, Colo., hydrographic work at 31–32
rating table for Clear Creek at 171
Fort Collins, Colo., hydrographic work near 36–37
Fort Duchesne, Utah, hydrographic work at 85–86
rating table for Uinta River at 174
Fort Hancock, Tex., hydrographic work near 71–72
Fortier, S., measurements by 16, 17, 18, 19, 20, 21, 22, 130
Fortification Creek at Craig, Colo., measurements of 98

Page.
Fort Tejon, Cal., rainfall at 169
Fournet, J. F., aid by 11
Franklin, Idaho, hydrographic work at 118
Fremont, Nebr., hydrographic work at 43
Fruto, Cal., hydrographic work near 143-144
rating table for Stony Creek near 178
Fullerton, Nebr., hydrographic work at 43

G.

Gallatin River at Logan, Mont., measurements of 17-18
Gallatin River (West) near Salesville, Mont., measurements of 16-17
rating table for 170
Gardnerville, Nev., hydrographic work near 108-109
rating table for East Fork of Carson River near 175
Geneva, Nebr., hydrographic work at 43
Gibbon, Oreg., hydrographic work at 137
rating table for Umatilla River at 177
Gila River at San Carlos, Ariz., measurements of 98-99
Glenn County, Cal., rainfall in 169
Glenwood Springs, Colo., hydrographic work at 92-93
rating table for Grand River at 174
Golconda, Nev., hydrographic work near 106-107
rating table for Humboldt River near 175
Gorman, Cal., rainfall near, at Smith ranch 169
Granada, Colo., hydrographic work near 54
Grand Forks, N. Dak., hydrographic work at 10-11
Grand Junction, Colo., hydrographic work at 98
Grand River, measurements of, at Glenwood Springs, Colo 92-93
measurements of, at Grand Junction, Colo 98
rating table for, at Glenwood Springs, Colo 174
Grandview, Idaho, hydrographic work near 127
Granite, Colo., hydrographic work at 47
Grasse, H. W., aid by 10
Greeley, Colo., hydrographic work at 55
Green River at Greenriver, Wyo., measurements of 82-83
rating table for 173
Greenriver, Wyo., hydrographic work at 82-83
rating table for Green River at 173
Greet, W. D., and Dillard, J. D., measurements by 75, 78, 79, 80, 81
Griffin, Cal., rainfall near, at Sneddens 169
Grindstone River, California, measurements of 167
Groveland, Cal., rainfall near 169
Grunsky, C. E., aid by 147, 148
Guadalupe River and tributaries, Texas, power from and measurements of 62-63

Page.
Guernsey, Wyo., hydrographic work near 27
rating table for North Platte River near 171
Gunnison, Utah, hydrographic work near 125-126
rating table for Sevier River near 176
Gunnison River, measurements of, at Iola, Colo 93-94
measurements of, at Whitewater, Colo 94-95
near Delta, Colo 98
rating table for, at Iola, Colo 174

H.

Hague, J., measurements by 71
Hall, C. M., work done by 9, 10, 11, 12, 13, 14
Hamilton, Colo., hydrographic work at 98
Harrison, C. L., aid by 29
Harroun, P. E., measurements by 66, 68
Hat River, California, measurements of 167
Havre, Mont., hydrographic work at 15-16
rating table for Milk River at 170
Hawley, R. W., work done by 51, 52
Hayden, Colo., hydrographic work at 98
Hayes, J. F., aid by 11
Healy, C. W., measurements by 71
Hebrew, S., aid by 31
Heerman, E. E., aid by 14
Heisler, H. G., work done by 99, 100, 104
Henderson, H. H., station established by 150
Herndon, Cal., hydrographic work at 151-152
rating table for San Joaquin River at 178
Hetch Hetchy Valley dam site, California, hydrographic work at 146-147
Hooper, Wash., hydrographic work near 136-137
rating table for Palouse River near 177
Hudson Bay drainage basin, measurements in 9-15
Humboldt River, measurements of, near Elko, Nev 104-105
measurements of, near Golconda, Nev 106-107
near Oreana, Nev 107-108
rating table for, near Elko, Nev 174
near Golconda, Nev 175
near Oreana, Nev 175
Humboldt River (south fork) at Mason's ranch, Nevada, measurements of 105-106
rating table for 174
Hunt, H., aid by 55
Hunt Creek at Yampa, Colo., measurement of 98
Hutchinson, Kans., hydrographic work at 56, 57
rating table for Arkansas River at 172
Hyrum, Utah, hydrographic work at 119-120
rating table for Blacksmith Fork at 176

I.

Ignacio, Colo., hydrographic work at 95-96
rating table for Los Pinos River at 174
Interior Basin, measurements in 104-126
Interlaken, Colo., hydrographic work at 55
International (Water) Boundary Commission, measurements made by hydrographers of 68
stations established by 71

Page.
ola, Colo., hydrographic work at 93-94
rating table for Gunnison River at 174
ola, Kans., hydrographic work near 57 58
rating table for Neosho River at 172
sabella, Cal., rainfall at 169

J.

anus, S., measurements by 99
efferson River at Sappington, Mont., measurements of 19-20
rating table for 170
ellys Ferry, California, hydrographic work at 142 143
rating table for Sacramento River at 177
olon, Cal., hydrographic work near 154-155
rating table for San Antonio Creek at 178
ones, H., aid by 90
ones, W., station established by 158
unction, Kans., hydrographic work at 43
rating table for Republican River at 171

K.

alawa River near Forks, Wash., measurements of 140-141
rating table for 177
ansas River at Lecompton, Kans., measurements of 46-47
rating table for 172
ansas River Basin, measurements in 41-47
aweah River, California, measurements of 167
eefe, T. F., aid by 162
ern County, Cal., rainfall in 169
ern River, California, measurements of, at first point of measurement, California 167
measurements of, near Bakersfield, Cal 158 159
ernville, Cal., rainfall near, at Bear Valley 169
ersey, Colo., hydrographic work at 37-38
rating table for South Platte River at 171
ing City, Cal., hydrographic work near 155
rating table for San Lorenzo Creek at 178
ing River, measurements of, near Kingsburg, Cal 153
measurements of, near Red Mountain, California 152-153
rating table for, near Red Mountain, California 178
ingsburg, Cal., hydrographic work near 153
iona, Wash., hydrographic work at 136
rating table for Yakima River at 177
remmling, Colo., hydrographic work at 98

L.

agrange, Cal., hydrographic work at 149, 150, 167
rating table for Tuolumne River at 178
agrange Ditch and Hydraulic Mining Company's canal, condition and measurements of 149
aguna, Cal., rainfall at 169

Page.
Lajunta, Colo., hydrographic work near 52
Lake County, Cal., rainfall in 169
Lake Creek, Utah, measurements of 55, 87-88
rating table for 174
Lakeport, Cal., rainfall at 169
Lamar, Colo., hydrographic work at 53
La Mesa, Cal., rainfall at 169
Langtry, Tex., hydrographic work near 75-76
Lecompton, Kans., hydrographic work at 46-47
rating table for Kansas River at 172
Leon River, Texas, flow of 60
Liberty, Kans., hydrographic work near 56-57
rating table for Verdigris River near 172
Lincoln, Nebr., hydrographic work at 43
Ling, L. H., measurements by 16
Lippincott, J. B., work done by 142, 143, 144, 146, 147, 148, 149, 150, 151, 152, 157, 159, 163
Little River, Texas, character and measurements of 60-61
Little River, Washington, measurements of 142
Little Rock Creek at Toponas, Colo., measurements of 98
Little Tujunga River, California, measurements of 167
Livingston, Ariz., hydrographic work near 99-101
Livingston, Mont., hydrographic work near 22
rating table for Yellowstone River near 170
Llano River, Texas, irrigation and power from and measurements of 62
Logan, Mont., hydrographic work at 17-18
Logan, Utah, hydrographic work near 118-119
rating table for Logan River at 176
Logan River near Logan, Utah, measurements of 118-119
rating table for 176
Los Angeles County, Cal., rainfall in 169
Los Angeles River, California, measurements of 160-161, 167
Los Pinos River at Ignacio, Colo., measurements of 95-96
rating table for 174
Lost Canyon Creek at Dolores, Colo., measurements of 98
Loup River near Columbus, Nebr., measurements of 38-39
Lower Lake, Cal., hydrographic work near 144-145
rating table for Cache Creek near 178
Lower Tule River, California, measurements of 167
Lower Twin Lakes, Colorado, hydrographic work at 55
Lyons, Colo., hydrographic work near 34-35
rating table for St. Vrain Creek near 171
supply ditch near, measurements of 35
Lytle Creek at head gates of Rialto canals, California, measurements of 162 163

M. Page.

McCloud River, California, measurements of 167
McCook, Nebr., hydrographic work at 43
McDonald, Wash., hydrographic work at and near 139-140, 141
rating table for Elwha River at 177
McDowell, Ariz., hydrographic work at and near 101-103
McKinney, E. G., aid by 36
Madison River near Redbluff, Mont., measurements of 18-19
rating table for 170
Magic Hill No. 1, California, rainfall at 169
Main, Mont., hydrographic work at 14-15
rating table for St. Mary River at 170
Mancos, Colo., hydrographic work at 97-98
Mancos River, at Mancos, Colo., measurements of 97-98
Manhattan, Kans., hydrographic work near 46
rating table for Blue River near 172
Mapleton, Utah, hydrographic work near 122-123
rating table for Spanish Fork near 176
Marett, E., aid by 83
Marias River near Shelby, Mont., measurements of 23
Mariposa County, Cal., rainfall in 169
Marshall, Colo., hydrographic work near 32-33
rating table for 171
Masten ditch near Susanville, Cal., measurements of 116
Matlock, S. M., observations by 30
Matthes, G. H., aid by 23
Medicine Bow, Wyo., hydrographic work at 26
rating table for Medicine Bow River at 170
Medicine Bow River at Medicine Bow, Wyo., measurements of 26
rating table for 170
Meeker, Colo., hydrographic work at 91-92
Meldrum, J., aid by 12
Merced Falls, Cal., hydrographic work near 150-151
rating table for Merced River above 178
Merced River above Merced Falls, Cal., measurements of 150-151
rating table for 178
Miles, Kans., rating table for 172
Milk Creek at Axial, Colo., measurements of 98
Milk River at Havre, Mont., measurements of 15-16
rating table for 170
(north fork) at McLeod trail ford, Montana, measurements of 23
(south fork) at Murphy's ranch, Montana, measurements of 23
Mill Creek, Texas, flow of and power from 62
Mill Creek canals at Crafton headworks, California, measurements of 166
Mills, A., aid by 71
Milo, Cal., rainfall at 169

Page.

Minichaduza River at Valentine, Nebr., measurements of 43
Mississippi River Basin in Colorado, stream measurements in 55
Missoula, Mont., hydrographic work at 131-132
rating table for Missoula River at 177
Missoula River at Missoula, Mont., measurements of 131
rating table for 177
Missouri River near Townsend, Mont., measurements of 20-21
rating table for 170
Missouri River Basin (upper), stream measurements in 15-25
Missouri River Commission, observations of gage heights by 20
Mitchell, Nebr., hydrographic work at 28
Modoc County, Cal., rainfall in 169
Mohave River at Victorville, Cal., measurements of 159-160
Mokelumne River at Electra, Cal., measurements of 145-146
rating table for 178
Montana, miscellaneous measurements in 23
Monterey County, Cal., rainfall in 169
Monte Vista, Cal., rainfall near, at Mount Sister Elsie 169
Montgomery Ferry, Idaho, hydrographic work at 126-127
Montrose, Colo., hydrographic work at 98
Moorhead, Minn., hydrographic work at 9-10
Moorhead, Tex., hydrographic work near 77-78
Morapes Creek at Hamilton, Colo., measurements of 98
Morrison, Colo., hydrographic work near 31
rating table for Bear Creek near 171
Morse River near Port Angeles, Wash., measurements of 142
Muddy Creek at Kremmling, Colo., measurements of 98
Mulholland, W., measurements by 160
Myrick, J. C., measurements by 101, 103
Mystic, Cal., hydrographic work near 112

N.

Naches River near North Yakima, Wash., measurements of 133-134
rating table for 177
Nacimiento Creek, California, measurements of 154, 167
Narrows (The), California, hydrographic work at 160-161
National City, Cal., rainfall near, at Sweetwater dam 169
Nebraska, stream measurements in 43
Neosho River near Iola, Kans., measurements of 57-58
rating table for 172
Nepesta, Colo., hydrographic work near 50-51
rating table for Arkansas River at 172
Newell, F. H., work done by 17, 108, 109
Niles, Kans., hydrographic work near 44
Niobrara, Nebr., hydrographic work at and near 43

Page.
Niobrara River, measurements of, at Niobrara, Nebr. 43
measurements of, at Valentine, Nebr. 25
Nolan River, Texas, discharge of 60
Norfolk, Nebr., hydrographic work at and near 40, 43
rating table for 171
Northern Pacific Coast drainage basin, measurements in 138-142
North Platte, Nebr., hydrographic work at 28, 43
North Platte River, measurements of, at Mitchell, Nebr. 28
measurements of, at North Platte, Nebr. 28
near Guernsey, Wyo. 27
rating table for, near Guernsey, Wyo. 171
North Yakima, Wash., hydrographic work near 133-134
rating table for Naches River near 177

O.

Oak Creek at Pinnacle, Colo., measurements of 98
Oakdale, Cal., hydrographic work near 146
Ogden, Utah, hydrographic work at 121
Ogden River at Ogden, Utah, measurements of 121
Oreana, Nev., hydrographic work near 107-108
rating table for Humboldt River near 175
Osgood, Mrs. C., aid by 33
Ouray School, Utah, hydrographic work at 86-87
rating table for Uinta River at 174
Owyhee Land and Irrigation Company, Idaho, station established for 127

P.

Pacoima River, California, measurements of 167
Page, J., aid by 94
Palmdale, Cal., rainfall near, at Palmdale headworks 169
Palouse River near Hooper, Wash., measurements of 136-137
rating table for 177
Parshall, A. J., work done by 23, 26, 27, 82
Pasadena, Cal., hydrographic work near 161
rainfall near, at Colby's Camp, No. 5 169
Pass Creek at Kremmling, Colo., measurements of 98
Pecos, Tex., hydrographic work near 76-77
Pecos River, measurements of, near Moorhead, Tex. 77, 78
measurements of, near Pecos, Tex. 76-77
Pembina, N. Dak., hydrographic work at 12-13
Piney, Cal., hydrographic work near 156
rating table for Arroyo Seco near 178
Pinnacle, Colo., hydrographic work at 98
Pit River, California, measurements of 167
Plateau Creek at Colbran, Colo., measurements of 98
Platte River, measurements of, at Fremont, Nebr. 43

Page.
Platte River, measurements of, near Columbus, Nebr. 39
See also North Platte River.
Platte River Basin, measurements in 26-41
Plumb, E. K., aid by 37
Pogue lower ditch, California, measurements of 167
Polson, Mont., hydrographic work at 132
Pomel, A., aid by 93
Port Angeles, Wash., hydrographic work near 142
Portersville, Cal., hydrographic work near 157-158
rating table for Tule River near 178
Powell, O. B., measurements by 81
Prairie Creek, Nebraska, measurements of 43
Prall, C. T., work done by 83, 84, 85, 86, 87, 88, 89
Precipitation. *See* Rainfall.
Presidio, Tex., hydrographic work near 72-75
Price road bridge, Utah, hydrographic work at 88-89
Priest Valley, California, rainfall at 169
Provo, Utah, hydrographic work near 123-124
rating table for Provo River near 176
Provo River near Provo, Utah, measurements of 123-124
rating table for 176
Prowers, Colo., hydrographic work at 53
rating table for Arkansas River at 172
Pueblo, Colo., hydrographic work at 49-50
rating table for Arkansas River at 172
Pysht River at the forks, Washington, measurements of 142

Q.

Quillayute, Wash., hydrographic work near 141-142
rating table for Soleduck River near 177

R.

Radersburg, Mont., hydrographic work near 21-22
Rainfall and rainfall stations in southern California, table showing 168-169
Rancheria Creek, California, measurement of 167
Red Bluff, Cal., hydrographic work near 142-143
rainfall at 169
Redbluff, Mont., hydrographic work at 18-19
rating table for Madison River near 170
Redding, Cal., rainfall at 169
Red Lake River at Crookston, Minn., measurements of 10-11
Redlands, Cal., rainfall near, at Mill Creek "A" 169
Red Mountain, California, hydrographic work near 152-153
rating table for King River near 178
Red River of the North, drainage basin of 9
measurements of, at Emerson, Manitoba 13
at Grand Forks, N. Dak. 11-12

Page.
Red River of the North, measurements of, at Moorhead, Minn 9-10
at Pembina, N. Dak 12-13
Regan, J. S., aid by 65
Reno, Nev., hydrographic work near 112
Republican River, measurements of, at Culbertson, Nebr 43
measurements of, at Junction, Kans 43
at McCook, Nebr 43
near Superior, Nebr 41-42
rating table for, at Junction, Kans 171
near Superior, Nebr 171
Rialto canals, California, hydrographic work at head gates of 162-163
Rico, Colo., hydrographic work at 98
Riley, B., aid by 54
Rio Grande, N. Mex., hydrographic work at 67-68
rating table for Rio Grande at 173
Rio Grande, measurements of, above Presidio, Tex 72-73
measurements of, below Presidio, Tex 74-75
at Cenicero, Colo 65-66
at Embudo, N. Mex 66-67
at Rio Grande, N. Mex 67-68
near Del Norte, Colo 65
near Devilsriver, Tex 80-81
near Eagle Pass, Tex 81-82
near El Paso, Tex 70
near Fort Hancock, Tex 71-72
near Langtry, Tex 75-76
near San Marcial, N. Mex 68-69
rating table for, at Cenicero, Colo 173
at Embudo, N. Mex 173
at Rio Grande, N. Mex 173
near Del Norte, Colo 173
Riverton, Cal., hydrographic work at and near 167
Rock Creek at Toponas, Colo., measurements of 98
Rockyford, Colo., hydrographic work near 51-52
Russell, W. G., measurements by 43, 44, 45, 46, 56

S.

Sacramento River, California, measurements of, above Pitt River 167
measurements of, at Iron Canyon 167
at Jelly's Ferry, California 142-143
rating table for, at Jellys Ferry, Cal 177
Sage Creek at Hayden, Colo., measurements of 98
St. Mary River at Main, Mont., measurements of 14-15
rating table for, at Main, Mont 170
tributaries of, measurements of 15
St. Vrain Creek near Lyons, Colo., measurements of 34-35
rating table for 171
Salesville, Mont., hydrographic work near 16-17
rating table for West Gallatin River near 170
Salida, Colo., hydrographic work at 47-48

Page.
Salina, Kans., hydrographic work near 44-45
rating table for Saline River near 172
Salina, Utah, hydrographic work near 124-125
Salina Creek near Salina, Utah, measurements of 124-125
Salinas, Cal., hydrographic work near 156-157
rating table for Salinas River near 178
Salinas River near Salinas, Cal., measurements of 156-157, 167
rating table for 178
Saline River near Salina, Kans., measurements of 44-45
rating table for 172
Salt Creek at Lincoln, Nebr., measurements of 43
Salt River, measurements of, at McDowell, Ariz 101-102
measurements of, at the reservoir site 99-100
San Antonio Creek, California, measurements of, at division weir in canyon 167
measurements of, near Jolon, Cal 154-155
rating table for, near Jolon, Cal 178
San Bernardino County, Cal., rainfall in 169
San Carlos, Ariz., hydrographic work at 98-99
San Diego, Cal., rainfall near, at Cuyamaca 169
San Diego County, Cal., rainfall in 169
San Francisco Bay drainage basin, measurements in 142-153
San Gabriel canals, California, measurements of 162
San Gabriel River, measurements of, at intake weir of San Gabriel Power Company's canal, California 167
measurements of, above Azusa, Cal 161
San Joaquin River, measurements of, at Herndon, Cal 151-152
measurements of, at Pollasky ford, California 167
rating table for, at Herndon, Cal 178
San Lorenzo Creek near King City, Cal., measurements of 155, 167
rating table for 178
San Marcial, N. Mex., hydrographic work near 68-69
San Pitch River near Gunnison, Utah, measurements of 125
rating table for 176
Santa Ana River, California, irrigation canals from, measurements of 164-165
measurements of, near Warmsprings, Cal 163-164, 167
Sappington, Mont., hydrographic work at 19-20
rating table for Jefferson River at 170
Savage, H. N., measurements by 166
Schadler, A. H., measurements by 110, 112
Schrum, E. A., aid by 31
Second Garotte, Cal., rainfall at 169
Sequoia, Cal., rainfall near, at Crockers 169

Page.
Sevier River near Gunnison, Utah, measurements of 126
rating table for 176
Shasta County, Cal., rainfall in 169
Shelby, Mont., hydrographic work near 23
Shell Creek and tributaries, Wyoming, measurements of 23
Siegfeldt, C., aid by 150
Sioux Falls, S. Dak., hydrographic work near 4-5
rating table for Big Sioux River near 170
Siskiyou County, Cal., rainfall in 169
Sisson, Cal., rainfall at 169
Smith, G. E., station established by 40
Smith, F. D., station established by 132
Smoky Hill River at Ellsworth, Kans., measurements of 45
rating table for 172
Snake River at Montgomery Ferry, Idaho, measurements of 126-127
Sneddens, Cal., rainfall at 169
Solado River, Texas, characters of 60
Soledad, Cal., rainfall near, at Priest Valley 169
Soleduck River near Quillayute, Wash., measurements of 141-142
rating table for 177
Solomon River near Niles, Kans., measurements of 44
rating table for 172
Sonora, Cal., rainfall at 169
South Boulder Creek, near Marshall, Colo., measurements of 32-33
rating table for 171
Southern California drainage basin, measurements in 154-169
South Platte River, measurements of, at Denver, Colo 30
measurements of, at Kersey, Colo 37-38
at North Platte, Nebr 43
rating table for, at Denver, Colo 171
at Kersey, Colo 171
South Platte River (south fork), measurements of, at Cheesman, Colo 29
South Tule River, California, measurements of 167
Spanish Fork, near Mapleton, Utah, measurements of 122-123
rating table for 176
Spokane, Wash., hydrographic work at 133
rating table for Spokane River at 177
Spokane River at Spokane, Wash., measurements of 133
rating table for 177
Squaw Creek, California, measurements of 167
Standish, Cal., hydrographic work near 115
Stanislaus River, near Oakdale, Cal., measurements of 146
Steamboat Creek at Steamboat Springs, Nevada, measurements of 114-115
rating table for 175
Steamboat Springs, Nevada, hydrographic work at 114-115
rating table for Steamboat Creek at 175

Page.
Stewart, Mrs. A., aid by 96
Stony Creek, near Fruto, Cal., measurements of 143-144
rating table for 177
Stout, O. V. P., work done by 24, 25, 28, 38, 39, 40, 41, 43
Sulphur Fork of Lampasas River, Texas, features of 60
Superior, Nebr., hydrographic work near 41-42
mill race near, measurements of 42
rating table for Republican River near 171
Surface Creek at Cedaredge, Colo., measurements of 98
Susan River near Susanville, Cal., measurements of 115-116
rating table for 175
Susanville, Cal., hydrographic work near 115-116
rating table for Susan River near 175
Sweetwater dam, California, rainfall at 169
Sweetwater River at Sweetwater dam, California, measurements of 166
Swendsen, G. L., work done by 117, 118, 119, 120, 122, 123, 124

T.

Tahoe, Cal., hydrographic work at 111-112
rating table for Truckee River at 175
Tanner, C., work done by 124, 125, 126
Taylor, C. V., measurements by 107, 110, 111, 112, 113, 114
Taylor, L. H., work done by 104-107, 108, 109, 110, 111, 112, 113, 114, 115, 116
Taylor, T. U., work done by 58, 59, 60, 61, 62, 64, 77
Tehachapi, Cal., rainfall at 169
Tehama County, Cal., rainfall in 169
Thermopolis, Wyo., hydrographic work near 23
rating table for Bighorn River near 176
Tieton River, Washington, features of 134-135
Tonto Creek near Livingston, Ariz., measurements of 100-101
Toponas, Colo., hydrographic work at 98
Townsend, Mont., hydrographic work near 20
rating table for Missouri River near 170
Trott, F. P., measurements by 101, 103
Troublesome Creek, Colorado, measurements of 98
Trout Creek at Pinnacle, Colo., measurements of 98
Truckee River, measurements of, at Nevada-California State line 112-113
measurements of, at Tahoe, Cal 111-112
at Vista, Nev 113-114
rating table for, at Nevada-California State line 175
at Tahoe, Cal 175
at Vista, Nev 175
Tujunga River, California, measurements of 167
Tulare County, Cal., rainfall in 169
Tule River near Portersville, Cal., measurements of 157-158
rating table for 178

Page.
Tuolumne County, Cal., rainfall in 169
Tuolumne River, California, measurements of 146, 147, 149, 167
rating table for, at Lagrange, Cal..... 178
Turlock Canal at Lagrange, Cal., measurements of 150

U.

Uinta, Utah, hydrographic work near 122
rating table for Weber River near 176
Uinta River, measurements of, at Fort Duchesne, Utah 85-86
measurements of, at Ouray School, Utah 86-87
near Whiterocks, Utah 84
rating table for, at Fort Duchesne, Utah 174
at Ouray School, Utah 174
near Whiterocks 173
Umatilla River at Gibbon, Oreg., measurements of 137
rating table for 177
Uncompahgre River at Delta and Montrose, Colo., measurements of 98
Union Gap, Wash., hydrographic work at 135
rating table for Yakima River at 177
United States Engineers, aid by 20
Upper Lake, California, rainfall at 169
Utah Light and Power Company, aid by 121

V.

Valentine, Nebr., hydrographic work at 25
Van Cleave, L. F., aid by 92
Ventura County, Cal., rainfall in 169
Verde River near McDowell, Ariz., measurements of 102-103
Verdigris Creek above Niobrara, Nebr., measurements of 43
Verdigris River near Liberty, Kans., measurements of 56-57
rating table for 172
Vernal, Utah, hydrographic work near 83-84
rating table for Ashley Creek near 173
Victorville, Cal., hydrographic work at 159-160
Vista, Nev., hydrographic work at 113-114
rating table for Truckee River at 175

W.

Waco, Tex., hydrographic work at 58-59
rating table for Brazos River at 173
Ware, W. J., measurements by 138, 139, 140, 141, 142
Warmsprings, Cal., hydrographic work near 163-164
Warren, A. K., aid by 158
Washington (northwestern), discharge measurements made in 142

Page.
Watertown, S. Dak., hydrographic work near 24
Watumna ditch, California, measurements of 167
Weber River near Uinta, Utah, measurements of 122
rating table for 176
Weiser, Idaho, hydrographic work near 129-130
rating table for Weiser River near 176
Weiser River near Weiser, Idaho, measurements of 129-130
rating table for 176
Weldon, Cal., rainfall near, at Taylor's ranch 169
Wesch, J., aid by 96
Westby, G. C., measurements by 131, 132
Western Gulf drainage basin, measurements in 58-82
West Gallatin River, near Salesville, Mont., measurements of 16-17
rating table for 170
White River, Colorado, features of 91
measurements of, at Meeker, Colo 91-92
near Buckley, Wash 138
Whiterocks, Utah, hydrographic work near 84-85
rating table for Whiterocks River near 173
Whiterocks River near Whiterocks, Utah, measurements of 85
rating table for 173
Whitewater, Colo., hydrographic work at 94-95
Wiley, A. J., station established by 127
Williams Fork at Hamilton, Colo., measurements of 98
Willis, R. H., measurements by 28
Willow Creek near Standish, Cal., measurements of 115
Wolaver, J. M., aid by 36
Woodfords, Cal., hydrographic work at 109-110
rating table for West Fork of Carson River at 175
Wymore, Nebr., hydrographic work at 43

Y.

Yakima River, measurements of, at Kiona, Wash 136
measurements of, at Union Gap, Wash 135
rating table for, at Kiona, Wash 177
at Union Gap, Wash 177
Yampa, Colo., hydrographic work at 98
Yampa River, Colorado, character of 89-90
measurements of, at Craig, Colo 90-91
Yampa River and forks, Colorado, measurements of 98
Yellowstone River near Livingston, Mont., measurements of 22
rating table for 170
Yuma, Ariz., hydrographic work at 104

O

1895.

Sixteenth Annual Report of the United States Geological Survey, 1894–95, Part II, Papers of an economic character, 1895; octavo, 598 pp.

Contains a paper on the public lands and their water supply, by F. H. Newell, illustrated by a large map showing the relative extent and location of the vacant public lands; also a report on the water resources of a portion of the Great Plains, by Robert Hay.

A geological reconnoissance of northwestern Wyoming, by George H. Eldridge, 1894; octavo, 72 pp. Bulletin No. 119 of the United States Geological Survey.

Contains a description of the geologic structure of portions of the Big Horn Range and Big Horn Basin, especially with reference to the coal fields, and remarks upon the water supply and agricultural possibilities.

Report of progress of the division of hydrography for the calendar years 1893 and 1894, by F. H. Newell, 1895; octavo, 126 pp. Bulletin No. 131 of the United States Geological Survey.

Contains results of stream measurements at various points, mainly within the arid region, and records of wells in a number of counties in western Nebraska, western Kansas, and eastern Colorado.

1896.

Seventeenth Annual Report of the United States Geological Survey, 1895–96, Part II, Economic geology and hydrography, 1896; octavo, 864 pp.

Contains papers on "The underground water of the Arkansas Valley in eastern Colorado," by G. K. Gilbert; "The water resources of Illinois," by Frank Leverett, and "Preliminary report on the artesian waters of a portion of the Dakotas," by N. H. Darton.

Artesian-well prospects in the Atlantic Coastal Plain region, by N. H. Darton, 1896; octavo, 232 pp., 19 plates. Bulletin No. 138 of the United States Geological Survey.

Gives a description of the geologic conditions of the coastal region from Long Island, New York, to Georgia, and contains data relating to many of the deep wells.

Report of progress of the division of hydrography for the calendar year 1895, by F. H. Newell, hydrographer in charge, 1896; octavo, 356 pp. Bulletin No. 140 of the United States Geological Survey.

Contains a description of the instruments and methods employed in measuring streams and the results of hydrographic investigations in various parts of the United States.

1897.

Eighteenth Annual Report of the United States Geological Survey, 1896–97, Part IV, Hydrography, 1897; octavo, 756 pp.

Contains a "Report of progress of stream measurements for the calendar year 1896," by Arthur P. Davis; "The water resources of Indiana and Ohio," by Frank Leverett; "New developments in well boring and irrigation in eastern South Dakota," by N. H. Darton; and "Reservoirs for irrigation," by J. D. Schuyler.

1899.

Nineteenth Annual Report of the United States Geological Survey, 1897–98, Part IV, Hydrography, 1899, octavo, 814 pp.

Contains a "Report of progress of stream measurements for the calendar year 1897," by F. H. Newell and others; "The rock waters of Ohio," by Edward Orton; and "A preliminary report on the geology and water resources of Nebraska west of the one hundred and third meridian," by N. H. Darton.

Part II of the Nineteenth Annual contains a paper on "Principles and conditions of the movements of ground water," by F. H. King, and one on "Theoretical investigation of the motion of ground waters," by C. S. Slichter.

1900.

Twentieth Annual Report or the United States Geological Survey, 1898–99, Part IV, Hydrography, 1900; octavo, 660 pp.

Contains a "Report of progress of stream measurements for the calendar year 1898," by F. H. Newell, and "Hydrography of Nicaragua," by A. P. Davis.

1901.

Twenty-first Annual Report of the United States Geological Survey, 1899–1900, Part IV, Hydrography, 1901; octavo, 768 pp.

Contains a "Report of progress of stream measurements for the calendar year 1899," by F. H. Newell; "Preliminary description of the geology and water resources of the southern half of the Black Hills and adjoining regions in South Dakota and Wyoming," by N. H. Darton; and "The High Plains and their utilization," by W. D. Johnson.

Such of the above papers as are published by the United States Geological Survey may be obtained on application until the edition is exhausted. Correspondence should be addressed to

The Director,
United States Geological Survey,
Washington, D. C.

WATER-SUPPLY AND IRRIGATION PAPERS.

1. Pumping water for irrigation, by Herbert M. Wilson, 1896.
2. Irrigation near Phoenix, Arizona, by Arthur P. Davis, 1897.
3. Sewage irrigation, by George W. Rafter, 1897.
4. A reconnoissance in southeastern Washington, by Israel C. Russell, 1897.
5. Irrigation practice on the Great Plains, by E. B. Cowgill, 1897.
6. Underground waters of southwestern Kansas, by Erasmus Haworth, 1897.
7. Seepage waters of northern Utah, by Samuel Fortier, 1897.
8. Windmills for irrigation, by E. C. Murphy, 1897.
9. Irrigation near Greeley, Colorado, by David Boyd, 1897.
10. Irrigation in Mesilla Valley, New Mexico, by F. C. Barker, 1898.
11. River heights for 1896, by Arthur P. Davis, 1897.
12. Underground waters of southeastern Nebraska, by N. H. Darton, 1898.
13. Irrigation systems in Texas, by W. F. Hutson, 1898.
14. New tests of pumps and water lifts used in irrigation, by O. P. Hood, 1898.
15, 16. Operations at river stations, 1897, Parts I, II, 1898.
17. Irrigation near Bakersfield, California, by C. E. Grunsky, 1898.
18. Irrigation near Fresno, California, by C. E. Grunsky, 1898.
19. Irrigation near Merced, California, by C. E. Grunsky, 1899.
20. Experiments with windmills, by Thomas O. Perry, 1899.
21. Wells of northern Indiana, by Frank Leverett, 1899.
22. Sewage irrigation, Part II, by George W. Rafter, 1899.
23. Water-right problems of the Bighorn Mountains, by Elwood Mead, 1899.
24, 25. Water resources of the State of New York, Parts I, II, by G. W. Rafter.
26. Wells of southern Indiana (continuation of No. 21), by Frank Leverett, 1899.
27, 28. Operations at river stations, 1898, Parts I, II, 1899.
29. Wells and windmills in Nebraska, by Erwin Hinckley Barbour, 1899.
30. Water resources of the Lower Peninsula of Michigan, by Alfred C. Lane, 1899.
31. Lower Michigan mineral waters, by Alfred C. Lane, 1899.
32. Water resources of Porto Rico, by H. M. Wilson, 1900.
33. Storage of water on Gila River, Arizona, by J. B. Lippincott, 1900.
34. Geology and water resources of southeastern South Dakota, by J. E. Todd.
35–39. Operations at river stations, 1899, Parts I–V, 1900.
40. The Austin dam, by Thomas U. Taylor, 1900.
41, 42. The windmill: its efficiency and use, Parts I, II, by E. C. Murphy, 1901.
43. Conveyance of water in irrigation canals, etc., by Samuel Fortier, 1901.
44. Profiles of rivers, by Henry Gannett, 1901.
45. Water storage on Cache Creek, California, by Albert E. Chandler, 1901.
46. Reconn. of Kern and Yuba rivers, Cal., by F. H. Olmsted and M. Manson.
47–52. Operations at river stations, 1900, Parts I–VI, 1901.
53, 54. Geol. and water resources Nez Perce Co., Idaho, Pts. I, II, I. C. Russell.
55. Geology and water resources of Yakima Co., Wash., by G. O. Smith, 1901.
56. Methods of stream measurement, 1901.
57. Deep borings in United States, Part I, by N. H. Darton, 1902.
58. Water storage on Kings River, California, by J. B. Lippincott, 1902.
59, 60. Development and application of water in southern California, Pts. I, II, by J. B. Lippincott, 1902.
61. Deep borings in United States, Part II, by N. H. Darton, 1902.
62, 63. Hydrography of Southern Appalachian region, Pts. I, II, by H. A. Pressey.
64. Accuracy of stream measurements, by E. C. Murphy, 1902.
65, 66. Operations at river stations, 1901, Parts I, II, 1902.

Other papers are in preparation. The endeavor is made to send these pamphlets to persons who have assisted in their preparation by replies to inquiries or otherwise. Requests made for a certain paper are granted whenever practicable, but it is impossible to comply with general demands, such as to have all of the series sent. Application should be made either to members of Congress or to

THE DIRECTOR,
UNITED STATES GEOLOGICAL SURVEY,
WASHINGTON, D. C.

9.13.67

DEPARTMENT OF THE INTERIOR

WATER-SUPPLY

AND

IRRIGATION PAPERS

OF THE

UNITED STATES GEOLOGICAL SURVEY

No. 67

THE MOTIONS OF UNDERGROUND WATERS.—SLICHTER

WASHINGTON
GOVERNMENT PRINTING OFFICE
1902

IRRIGATION REPORTS.

The following list contains titles and brief descriptions of the principal reports relating to water supply and irrigation prepared by the United States Geological Survey since 1890:

1890.

First Annual Report of the United States Irrigation Survey, 1890; octavo, 123 pp.

Printed as Part II, Irrigation, of the Tenth Annual Report of the United States Geological Survey, 1888-89. Contains a statement of the origin of the Irrigation Survey, a preliminary report on the organization and prosecution of the survey of the arid lands for purposes of irrigation, and report of work done during 1890.

1891.

Second Annual Report of the United States Irrigation Survey, 1891; octavo, 395 pp.

Published as Part II, Irrigation, of the Eleventh Annual Report of the United States Geological Survey, 1889-90. Contains a description of the hydrography of the arid region and of the engineering operations carried on by the Irrigation Survey during 1890; also the Statement of the Director of the Survey to the House Committee on Irrigation, and other papers, including a bibliography of irrigation literature. Illustrated by 30 plates and 4 figures.

Third Annual Report of the United States Irrigation Survey, 1891; octavo, 576 pp.

Printed as Part II of the Twelfth Annual Report of the United States Geological Survey, 1890-91. Contains "Report upon the location and survey of reservoir sites during the fiscal year ended June 30, 1891," by A. H. Thompson; "Hydrography of the arid regions," by F. H. Newell; "Irrigation in India," by Herbert M. Wilson. Illustrated by 93 plates and 190 figur

Bulletins of
by F. H
No. 3
Irrigati
Montan
Irrigati
tion in

NO.

Library
State School of Mines,
Rapid City, South Dakota.

Irrigation o
Septem

Contai
the tota
of numb
of irriga
a descri
location

Thirteenth
III, Irr

Consis
irrigati
Wilson;
by A. H

A geologica
octavo, 108 pp., 12 plates. Bulletin No. 108 of the United States Geological Survey.

Contains a description of the geologic structure in and adjacent to the drainage basin of Yakima River and the great plains of the Columbia to the east of this area, with special reference to the occurrence of artesian waters.

1894.

Report on agriculture by irrigation in the western part of the United States at the Eleventh Census, 1890, by F. H. Newell, 1894; quarto, 283 pp.

Consists of a general description of the condition of irrigation in the United States, the area irrigated, cost of works, their value and profits; also describes the water supply, the value of water, of artesian wells, reservoirs, and other details; then takes up each State and Territory in order, giving a general description of the condition of agriculture by irrigation, and discusses the physical conditions and local peculiarities in each county.

Fourteenth Annual Report of the United States Geological Survey, 1892-93; Part II, Accompanying papers, 1894; octavo, 597 pp.

Contains papers on "Potable waters of the eastern United States," by W J McGee; "Natural mineral waters of the United States," by A. C. Peale; "Results of stream measurements," by F. H. Newell. Illustrated by maps and diagrams.

(Continued on third page of cover.)

DEPARTMENT OF THE INTERIOR

WATER-SUPPLY

AND

IRRIGATION PAPERS

OF THE

UNITED STATES GEOLOGICAL SURVEY

No. 67

WASHINGTON
GOVERNMENT PRINTING OFFICE
1902

UNITED STATES GEOLOGICAL SURVEY

CHARLES D. WALCOTT, DIRECTOR

THE MOTIONS OF UNDERGROUND WATERS

BY

CHARLES S. SLICHTER

WASHINGTON
GOVERNMENT PRINTING OFFICE
1902

CONTENTS.

	Page.
LETTER OF TRANSMITTAL	11
CHAPTER I.—Origin and extent of underground waters	13
Depth of ground water	14
Total amount of underground water	14
Permeability of rocks	15
Porosity of rocks and soils	16
Motion of the water	17
Cause and rate of movement	17
The laws of flow	18
Mechanical analysis of soils	21
The author's formula for determining flow	24
Maximum flow	28
CHAPTER II.—Surface zone of flow of ground waters	31
Underground drainage basins	32
Shape of the water table	33
The underflow	38
Rate of movement of the underflow	41
Return waters from irrigation	43
Effect of tile drainage, etc	46
Chlorine method of determining the rate of the underflow	46
The author's method of determining the rate of the underflow	48
Conclusions	50
CHAPTER III.—Deep zones of flow	52
Distinguishing features	53
Percolation into deep zones	54
Dakota formation	57
Potsdam formation	59
CHAPTER IV.—Recovery of underground water from the surface flows	61
Common open wells	62
Contamination of surface wells	68
Nonuniformity of neighboring wells	69
Fluctuations in the position of the water table and the effect on wells and springs	70
Available supply of wells and springs	73
Collecting galleries and subcanals	73
Subsurface dams	76
Advantages of underground supply	77
CHAPTER V.—Artesian and deep wells	79
Yield or capacity of artesian wells	83
Simple methods of measuring the yield of flowing wells	90
Failure of artesian wells	93
Mutual interference of artesian wells	95
Artesian wells of Savannah, Ga	97
INDEX	103

ILLUSTRATIONS.

Page.

PLATE I. Sections of Wisconsin sandstone: *A*, Red sandstone from Laville; *B*, Brown sandstone from Argyle 20

II. *A*, Sink-hole connection with underground drainage system; *B*, Underground channel 32

III. Map showing the deltas or fans of disappearing streams as they leave their mountain canyons 38

IV. *A*, Spring formed at outcrop of an impervious floor; *B*, Artesian well 62

V. *A*, View looking up the Pacoima Wash from the site of the subsurface dam; *B*, View of 50-foot section of subsurface dam on the Pacoima Wash, showing excavation and lagging 74

VI. View from bottom of 50-foot section of Pacoima subsurface dam, showing lagging in place and construction of concrete wall 76

VII. *A*, View of top of completed subsurface dam on the Pacoima Wash, showing wells on upper side of same; *B*, View of central portion of subsurface dam on the Pacoima Wash during overflow 78

VIII. Lines of flow into a well in a region in which the ground water has a constant motion in a general direction 82

FIG. 1. Ideal section across a river valley, showing the position of the ground water and the undulations of the water table with reference to the surface of the ground and bed rock 13

2. Diagram illustrating Darcy's law of the flow of water through a column of soil 18

3. Hazen's experimental filter for the determination of the laws of flow of water through sand and the evaluation of the transmission constant of the same 19

4. Unit rhombohedron formed by passing planes through the centers of eight contiguous spheres in the most compact packing of a mass of spheres, and showing the shape of the pores in such a mass 20

5. Unit element of the pore space in a mass of spheres packed in the most compact manner possible, being a plaster cast of the interior of the solid of fig. 4 21

6. Diagram illustrating Hazen's method of making mechanical analyses of soils 23

7. Diagram illustrating various pressure gradients and the maximum flow 28

8. Diagram showing lines of flow into a drainage ditch and the shape of the water table in its neighborhood 29

9. Contour map showing position of the water table, supposed lines of motion of ground water, and the thalwegs or drainage lines 33

Page.

FIG. 10. Diagram illustrating Chalon's principle that the main core of the underground drainage, or subterranean thalweg, naturally lies nearer the steeper side of the valley than does the surface stream. 34
11. Diagram illustrating lines of flow of ground water over a series of monoclines, synclines, and anticlines 34
12. Diagram illustrating lines of flow of ground water over a series of monoclines in an impervious bed 35
13. Diagram illustrating lines of motion of ground water in an outcrop of a pervious bed underlain and overlain with impervious strata 36
14. Diagram showing seepage lines in a pervious bed resting upon an impervious floor 37
15. Diagram showing direction and rate of seepage in a pervious bed resting upon an impervious floor 38
16. Diagram showing growth of Cache la Poudre River 44
17. Curve obtained in determining the velocity of ground water by the chlorine method 47
18. Diagram illustrating the author's electrical method of determining the horizontal velocity of ground water 48
19. Curve obtained by the author's electrical method of determining the velocity of ground water 49
20. Cross section through South Dakota artesian basin, based upon published data of Darton, Todd, and others 55
21. Diagram illustrating how gas and oil have been retained beneath anticlines of shale during protracted geologic intervals, thus proving the substantial imperviousness of the covering 56
22. Darton's map of catchment area of the Dakotas and the Dakota artesian basin 57
23. Section along the Missouri River near Great Falls, Mont 58
24. Wisconsin outcrop of Potsdam and St. Peter sandstones 59
25. Diagram showing the formation of a stratum spring at an outcrop of an inclined impervious stratum 61
26. Diagram showing the formation of overflow springs at the edges of a basin of impervious material 61
27. Diagram showing the formation of chasm springs in a cut which extends below the natural level of ground waters 62
28. Common dug well; shallow in water 63
29. Diagram illustrating the changing position of the water table near a 3-inch well during ten consecutive hours of continuous pumping at an average rate of 2,313 gallons per day 64
30. Diagram illustrating the varying position of the water table in a well due to pumping for various intervals and modified by rainfall and stops of various duration 65
31. Hoadley's laboratory apparatus for the investigation of the phenomena of common open and driven wells 66
32. Combination dug and tubular well 67
33. Diagram showing rise of water in city well at Garden, Kans., after heavy pumping 68
34. Curve showing rise of water surface in well at Garden, Kans 68
35. Diagram illustrating danger of contamination of surface wells from cesspools 69
36. Diagram showing extreme irregularities of the water table and the depth of wells in east Schleswig-Holstein 70

Page.

FIG. 37. Diagram showing fluctuation of the height of the ground water and associated phenomena as observed at Munich 71
38. Diagram showing fluctuation of the height of the ground water and associated phenomena as observed at Berlin 72
39. Autograph record of simultaneous changes in flow of spring and atmospheric pressure 73
40. Diagram illustrating Salbach's theory of the contamination of wells or collecting galleries by reversed flow from rivers 73
41. Diagram illustrating principle involved in construction of infiltration galleries for gravity flow 74
42. Plan of infiltration galleries proposed by Willard D. Johnson 75
43. Longitudinal section of infiltration galleries designed by Willard D. Johnson 76
44. Map showing location of springs in the vicinity of South Britain, Conn 80
45. Diagram illustrating the fall of pressure as water moves through a pervious material 83
46. Diagram illustrating the author's graphical solution of problems in the yield of artesian wells 87
47. Diagram illustrating graphical solution of an artesian-well problem 88
48. Graphical representation of the relations between Q and Q_0 in the equation on page 85 89
49. Diagram illustrating flow from vertical and horizontal pipes 91
50. Map showing location of artesian wells at Savannah, Ga 98

LETTER OF TRANSMITTAL.

DEPARTMENT OF THE INTERIOR,
UNITED STATES GEOLOGICAL SURVEY,
DIVISION OF HYDROGRAPHY,
Washington, D. C., March 26, 1902.

SIR: I have the honor to transmit herewith a manuscript by Prof. Charles S. Slichter on the motions of underground waters, and request that it be printed in the series of Water-Supply and Irrigation Papers. Professor Slichter has been giving considerable time and attention to experimental and theoretical considerations of the movements of underground waters, the preliminary results of which were published in Part II of the Nineteenth Annual Report. The present paper treats of the simpler and more general topics connected with the movements of water underground, being intended to answer the more elementary questions which arise in a consideration of the subject. Examples are given of the various areas in which water occurs underground, the origin and extent of the waters are discussed, and methods of bringing them to the surface and making them available are touched upon.

Very respectfully,

F. H. NEWELL,
Hydrographer in Charge.

Hon. CHARLES D. WALCOTT,
Director United States Geological Survey.

THE MOTIONS OF UNDERGROUND WATERS.

By Charles S. Slichter.

CHAPTER I.

ORIGIN AND EXTENT OF UNDERGROUND WATERS.

All underground waters have their origin in rainfall. A part of the rainfall immediately runs off the surface of the ground into the streams and rivers, just as the rain is diverted by the roof of a house into the gutters and spouts. Another portion of it is absorbed temporarily by the surface soil, but is again returned to the atmosphere by evaporation, either directly or through the agency of vegetation. A third portion penetrates the lower levels of the soil, there to become a part of the great mass of underground water and help to furnish the perennial supply of streams and lakes, of springs and wells, and to take part in geologic work of the most profound importance.

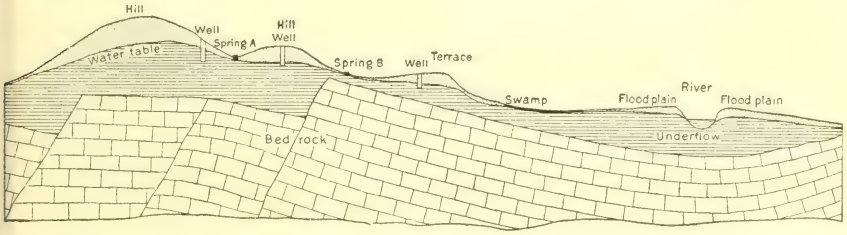


Fig. 1.—Ideal section across a river valley, showing the position of the ground water and the undulations of the water table with reference to the surface of the ground and bed rock.

In its downward course through the soil the rain water soon reaches a level at which the soil is completely saturated. The surface of this saturated zone is known as the water table or water plane. It is the water existing in the soil or rocks below this water table which is usually included in the term underground water. Above the zone of saturation the soil usually contains a large percentage of moisture, which plays a most important part in the growth of plants and in the physical, chemical, and biological phenomena of the soil. The consideration of the phenomena in this nonsaturated portion of the soil does not, however, come within the scope of this paper.

The depth of the water table below the surface of the ground varies much in different localities. In regions of copious rainfall it is usually but a few feet below the surface. In arid regions its depth may be measured in hundreds of feet. In general the water table

follows contours very similar to those of the land surface, but its undulations and slopes are of much less magnitude than those of the surface of the ground. This is shown in the ideal section forming fig. 1. A region in which the water table lies at great depth below the surface of the ground is, of course, a region of deep wells. A locality where the water table coincides with the surface of the ground is a swamp or marsh.

DEPTH OF GROUND WATER.

The lowest theoretical limit at which ground waters can exist is reached when the pressure in the rocks, due to the weight of the superincumbent material, is so enormous that all cavities and pores in the rock are completely closed. This limit has been shown by Professor Van Hise to be at a depth of approximately 6 miles.[a] The region above this depth Van Hise has distinguished as the zone of fracture, for in it pressures and stresses result in the actual breaking and fracturing of the rock. The region below this depth has been called by Van Hise the zone of flowage, for in it the enormous pressures will not permit the formation of cracks and cavities, and the rocks, when transformed by stresses, must actually flow like clay under the pressure of the hand. Adopting, then, this fundamental classification of Van Hise, we may say that the lower limit of the existence of ground water is found when we reach the lower boundary of the zone of fracture. This limit, however, refers primarily to the geologic work of ground waters and not to the practical limit of its occurrence in quantities sufficient for economic uses, for, as will be seen later, the principal zones from which underground water is actually recoverable in useful quantities are almost completely confined to the domain of sedimentary rocks and surface deposits. Even the mineral and thermal springs from beds of crystalline or metamorphic rocks are from a level much above the geologic limit of depth.

TOTAL AMOUNT OF UNDERGROUND WATER.

The amount of ground water within the crust of the earth is enormous. The writer estimates the entire amount to be about 565,000 million million cubic yards, or about 430,000 million million cubic meters. He has arrived at this result by considering that the geologic limit of the existence of ground water is at an average depth of 6 miles below the surface of the land and 5 miles below the floor of the ocean. The land surface and water surface he has assumed to be 52,000,000 square miles and 144,700,000 square miles, respectively. The average pore space of the surface rocks which is occupied by water or moisture he has taken as 10 per cent of their total volume. He believes that this estimate of 10 per cent is too large rather than too small. It forms, however, a convenient basis for the estimates.

[a] Principles of North American pre-Cambrian geology, by C. R. Van Hise: Sixteenth Ann. Rept U. S. Geol. Survey, Pt. I, 1896, p. 593.

According to these estimates, the total amount of underground water is sufficient to cover the entire surface of the earth to a uniform depth of from 3,000 to 3,500 feet. Assuming a mean depth of the ocean of 12,000 feet leads to the conclusion that the total amount of oceanic water is about 1,800,000 million million cubic yards, so that the total quantity of ground water is nearly one-third the amount of the oceanic water.

Former estimates of the quantity of underground water the writer believes to be entirely too large. The most frequently quoted estimate is that of Achille Delesse.[a] He estimates that the average amount of water in the surface rocks is 5 per cent by weight or 12½ per cent by volume. He supposes that the increase of temperature in the interior of the earth (1° C. for 100 feet) would limit the existence of water in the liquid form to a depth of 3,300 meters if it were not for the increase of pressure due to this great depth. Allowing for this, Delesse estimates that liquid water may exist at a depth of 18,500 meters and at a temperature of 600° C. These considerations lead him to the enormous estimate of 1,530,000 million million cubic yards (1,175,089 million million cubic meters). This, he says, is one nine hundred and twenty-first of the volume of the globe, which is nearly equal to Beaumont's estimate of the volume of the sea, one eight hundred and twenty-seventh of the the earth's volume.

The discovery of Van Hise that pores can not exist in the rocks at a depth much greater than 10,000 meters requires us to throw out these older estimates based upon the temperature gradient of the earth's crust.

PERMEABILITY OF ROCKS.

It has been tentatively assumed that all rocks are pervious to water. In a very general sense this may be said to be the case. Practically all rocks, even those of greatest strength, are not entirely solid masses of matter, but instead are collections of discrete particles and crystals more or less perfectly cemented and compacted together. This fact is much better understood when it is remembered that all except igneous rocks were at one time deposits laid down on the bottom of the sea by rivers and currents. These sediments may in time be changed to sedimentary rocks, and the sedimentary rocks in turn be changed to harder and more compact metamorphic and crystalline rocks, yet the original granular character of the mass is rarely completely lost, even in its changed condition, and the open texture persists, in some degree, forever. The small spaces or pores between the rock particles are usually occupied by water.

In building the St. Gothard tunnel the rocks encountered from the southern end were "principally mica-schist, hornblende rock and gneiss containing more hornblende and mica and quartzite," yet the

[a] Bull. Soc. géol. France, second series, Vol. XIX, 1861-62, p. 64.

contained water was so great that the grade of the tunnel had to be changed from 1:1,000 to 1:500 in order to obtain proper drainage.[a]

A portion of the underground water may be found in the larger cracks and crevices of the rocks, but by far the larger portion exists in the minute pores and openings between the rock particles themselves or in the small interstices between the separate grains of the soil.

POROSITY OF ROCKS AND SOILS.

The fractional part of a rock or of soil which is occupied by open spaces or voids determines its porosity. Thus, if a gallon of sand will hold, when saturated, three-tenths of a gallon of water, the porosity of the sand is said to be 30 per cent, three-tenths of its volume being made up of pores between the grains of sand. Likewise, if a cubic foot of sandstone will hold, when saturated, one-quarter of a cubic foot of water, the sandstone is said to have a porosity of 25 per cent, for one-fourth of its volume is pore space or voids.

The following table (I) contains several determinations of the porosities of Wisconsin building stones, made by Mr. E. R. Buckley, State geologist. They are probably the most carefully made determinations yet published. Special attention is called to the fact that all of the rocks listed in the table are building stones and that the important water-bearing rocks naturally show higher porosities than the more compact of these. From the table it is seen that the amount of open or unoccupied space in these building stones varies from about 1 part in 400 for the Montello granite to more than 1 part in 4 for the Dunnville sandstone. It is worthy of remark in this connection that the Montello granite was selected for the sarcophagus of the tomb of Gen. U. S. Grant, because comparative tests showed it to be the strongest granite in this country. Its porosity here given (about one-fourth of 1 per cent) shows that even the strongest rocks are measurably porous.

TABLE I.

Porosities of Wisconsin building stones, as determined by E. R. Buckley, State geologist.

Kind of stone.	Name of quarry.	Average porosity of two specimens.
		Per cent.
Granite	Berlin (Wis.) Granite Co	0.384
Do	Montello (Wis.) Granite Co	0.237
Niagara limestone	Marblehead (Wis.) Lime and Stone Co	0.77
Do	Story Bros., Wauwatosa, Wis	6.4
Lower Magnesian limestone.	Bridgeport, Wis	13.19
Sandstone	Chicago and Northwestern Railway., Ableman, Wis	5.6
Do	Bass Island (Wis.) and Lake Superior Sandstone Co., Ashland, Wis.	20.7
Do	Dunnville, Wis	28.26

[a] Tunneling, Explosive Compounds, and Rock Drills, by Henry S. Drinker, New York, 1878, p. 276.

The porosity of quartz sand will usually vary between 30 and 40 per cent, and that of clay loams between 40 and 50 per cent, depending upon the variety of sizes in the mixture and the manner of packing the particles.

MOTION OF THE WATER.

In general the water contained in the porous soils and rocks is not stationary, but possesses an exceedingly slow, although perfectly definite, motion. The best evidence of this is supplied by geology, which shows that nearly all of the rocks have been vastly changed by the work of underground waters. Enormous amounts of material have been slowly deposited in the pores of loose sandstones and limestones, until they have been converted into strong and nearly impervious rocks. Professor Van Hise estimates that thousands of cubic miles of dissolved quartz have been deposited by the slowly moving ground waters in sands and sandstones, until in some instances the latter have been converted into solid quartzite.[a] Almost any specimen of rock, especially if examined in thin sections under the microscope, will show some evidence of the work of moving ground waters. In many cases broken and worn fragments of crystals will be observed to have been patched and mended and added to until this so-called "secondary growth" has become a most important part of the rock. In other cases cementing material and minerals not originally present are found distributed throughout the rock in great abundance. Indeed the solution, transportation, and redepositing of material through the agency of ground waters is a geologic fact of profoundest importance, and is in evidence everywhere within the surface rocks of the earth.

CAUSE AND RATE OF MOVEMENT.

The cause of the motion of water through a porous medium is the same as the cause of the water movement through the pipes and conduits of a water-supply plant of a city—the difference of pressure from point to point. The difference in pressure in the case of ground waters is nearly always due to gravity alone. The water moves in the underground current for the same reason that water moves in the surface streams—it flows from a higher to a lower level.

The rate of the movement of water through a porous soil or rock depends upon several important elements, which may be enumerated as follows: (1) The size of the pores in the water-bearing medium, the capacity to transmit water being enormously greater for large pores than for small pores; (2) the porosity of the material, the flow being much greater for high porosity than for low porosity, other things being equal; (3) the pressure gradient, or the change in the pressure, or head, per unit of length measured in the direction of the motion,

[a] Earth movements; presidential address of C. R. Van Hise: Trans. Wisconsin Acad. Sci., Vol. XI. 1896, p. 511.

the flow being greater, of course, for high gradients than for low gradients; and (4) the temperature of the water, the flow being noticeably greater for high temperatures than for low temperatures.

THE LAWS OF FLOW.

Many experimenters have attempted to discover the exact law followed by water when traversing a porous medium, and to express that law by means of a mathematical formula. The earliest attempt to deduce such a law was made in 1856 by a Frenchman named Darcy,[a] who announced that the flow of water in a certain direction through a column of soil is proportional to the difference in pressure at the ends of the column and inversely proportional to the length of the column. According to this law, doubling the length of the soil

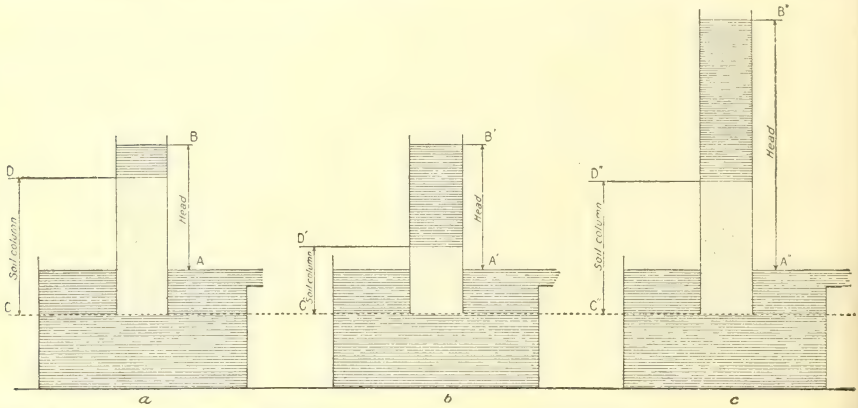


FIG. 2.—Diagram illustrating Darcy's law of the flow of water through a column of soil. The length of the soil column in case *a* is C D, and the difference in pressure at the ends of the column is A B. In case *b* the length of the soil column (C′ D′) is one-half of C D of case *a*, while the pressure difference (A′ B′) is the same as A B of case *a*. Therefore, according to Darcy's law, the flow in case *b* is twice that in case *a*. Likewise the flow in case *c* is twice that in case *a*, since the soil column is of the same length as in case *a*, while the pressure difference (A″ B″) is twice A B of case *a*. The amounts of the flows in cases *b* and *c* are equal to each other, for the length of the column of soil and the pressure difference are each double those of case *b*, which, according to Darcy's law, makes the flows equal.

column and keeping the water pressure the same at the ends will result in halving the flow, while doubling the pressure differences at the ends of the column and keeping the length of the column the same will result in doubling the flow. These facts are illustrated in fig. 2. Darcy expressed his conclusions by the following formula:

$$v = k\frac{p}{h}, \tag{1}$$

in which v stands for the velocity of the moving ground water, p the difference in pressure at the ends of the column of soil (measured usually by the height of the water column, as in fig. 2), h the length of the column, and k a constant depending upon the character of

[a] Les fontaines publiques de la ville de Dijon, by H. Darcy, Paris, 1856.

the soil, especially upon the size of the soil grains, which must be experimentally determined in each case by the use of apparatus similar to that shown in fig. 2.

Numerous other experimenters have investigated the same problem, with results substantially the same. Among the most important of these is the result of an American engineer, Mr. Allen Hazen,[a] whose conclusions are expressed by the following formula:

$$v = cd^2 \frac{h}{l} (0.70 + 0.03t), \tag{2}$$

in which v is velocity of the water, in meters daily, in a solid column of the same area as that of the sand, c is a constant factor which

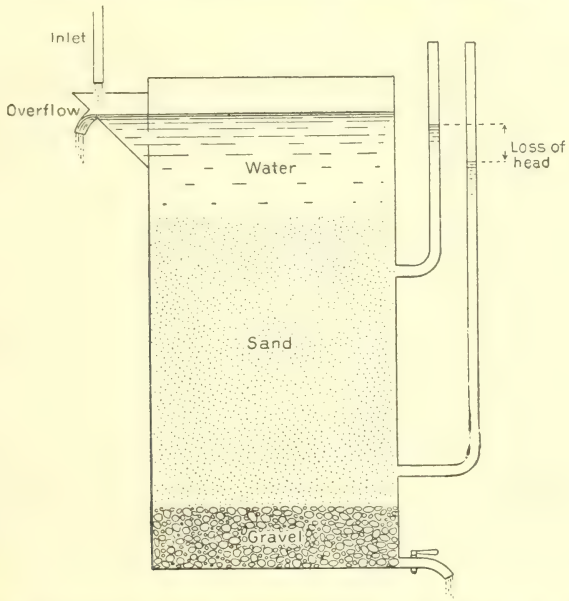


FIG. 3.—Hazen's experimental filter for the determination of the laws of flow of water through sand and the evaluation of the transmission constant of the same. The length of the soil column must be measured between the points at which the pressure gages enter the large cylinder filled with sand or other material subject to experimentation.

Hazen's experiments indicate to be approximately 1,000, d is the "effective size" of sand grain (measured in millimeters), which is such that 10 per cent of the material is of smaller grains and 90 per cent of larger grains than the size given, h is the loss of head, l is the thickness of sand through which water passes, and t is the temperature on the centigrade scale. Hazen states that the loss of head should be measured from points just inside the ends of the soil column, as is shown in the accompanying illustration of his apparatus, fig. 3.

[a] Some physical properties of sands and gravels, by Allen Hazen: Rept. Massachusetts State Board of Health, 1892, p. 541.

Hazen's work has been the basis on which the estimates of American engineers have been founded and has become standard.

Prof. F. H. King, in a long series of carefully conducted experiments, showed that the flow of water may increase somewhat faster than the pressure.[a] The formulas given herewith, however, are quite accurate enough for all engineering purposes to which they properly apply, although the refinement of a second approximation may result in a slight modification.

In another paper[b] the writer has given an expression for the flow of water or other fluid through a column of soil made up of uncemented grains of nearly uniform size and of a well-rounded or approximately spherical form. It was there shown that a mass of spheres thrown together in a haphazard way will present great variety in the amount

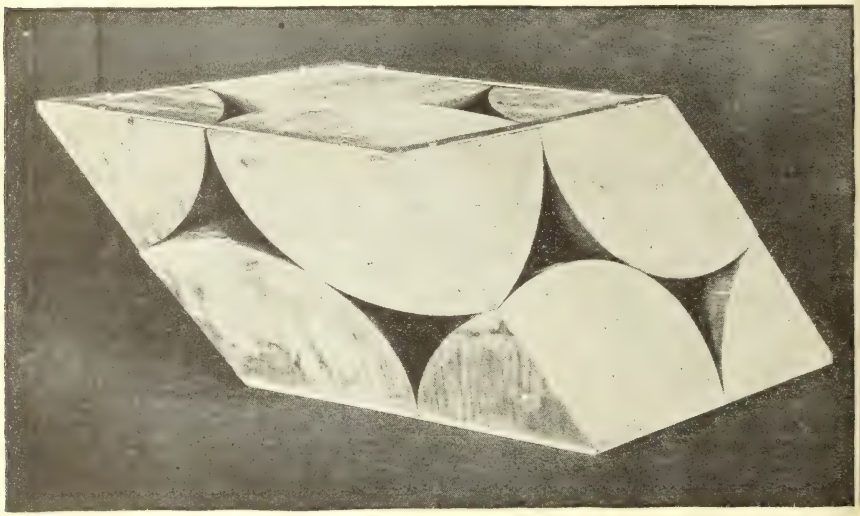


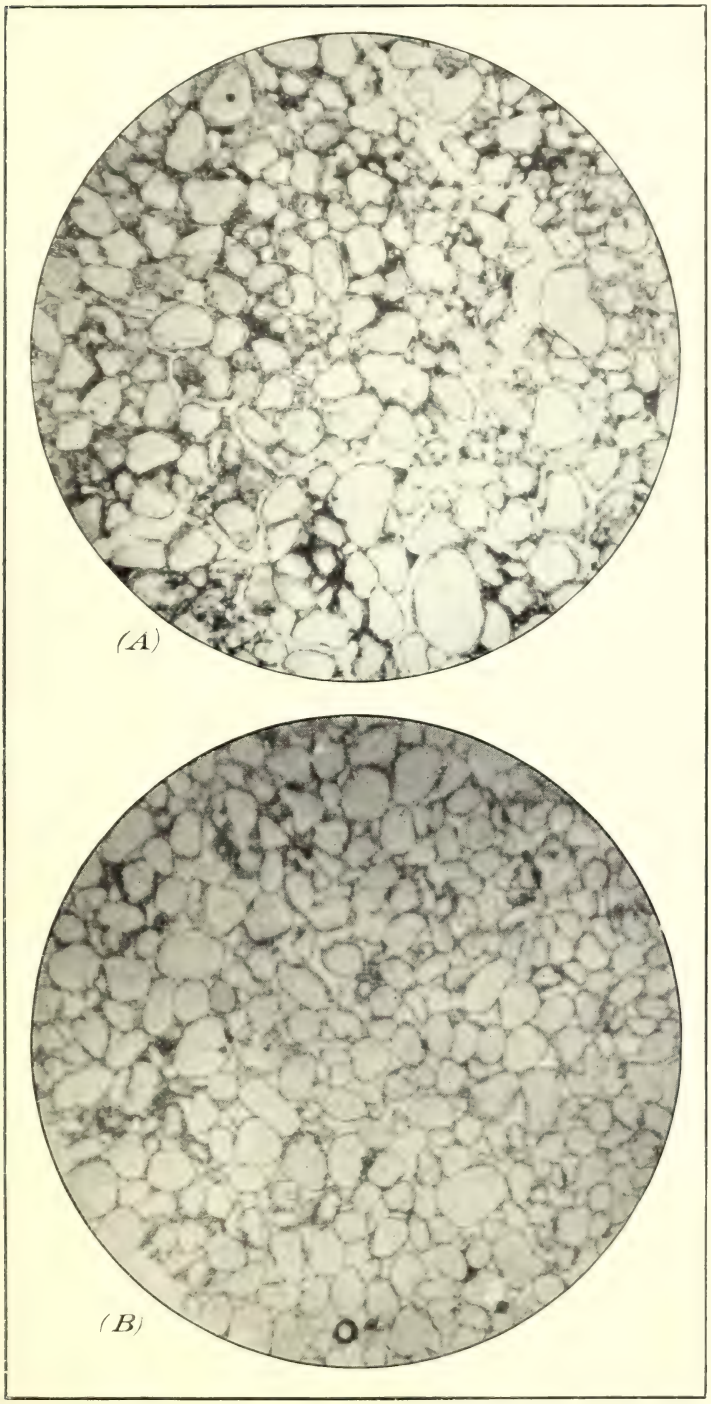
FIG. 4.—Unit rhombohedron formed by passing planes through the centers of eight contiguous spheres in the most compact packing of a mass of spheres, and showing the shape of the pores in such a mass.

of open space or porosity within the mass. The value of the porosity is shown to be independent of the size of the grains but dependent merely upon the manner of packing. The minimum porosity of a mass of spheres, or the porosity when the spheres are packed in the most compact manner possible, was shown to be 25.95 per cent of the whole space occupied by the spheres. The maximum porosity that is probable in a mass of spheres was shown to be 47.64 per cent of the whole space occupied.

If a quantity of common shot be poured into a glass and the amount of open space between the shot be determined by measuring the

[a] Principles and conditions of the movements of ground water, by F. H. King: Nineteenth Ann. Rept. U. S. Geol. Survey, Pt. II, 1899, p. 59.

[b] Theoretical investigation of the motion of ground waters, by C. S. Slichter: Nineteenth Ann. Rept. U. S. Geol. Survey, Pt. II, 1899, p. 295.



SECTIONS OF WISCONSIN SANDSTONE.

A, Red sandstone from Laville; *B*, brown sandstone from Argyle

quantity of water required to fill the pores between the shot, it will be found that the resulting porosity will be well within the limits just given. It will also be found that the porosity will vary greatly if different methods be used in filling the glass, but that it is possible to obtain the same porosity with small shot as with large shot. The pores between the shot will be seen to be somewhat triangular in form, as shown in figs. 4 and 5, and they are both larger in diameter and shorter in length for a packing of spheres having a large porosity than they are for a packing of low porosity. This very important element in the transmission capacity of a soil the writer has attempted to take proper account of in the derivation of the formula given on page 24. The individual grains in a mass of sand are not, of course,

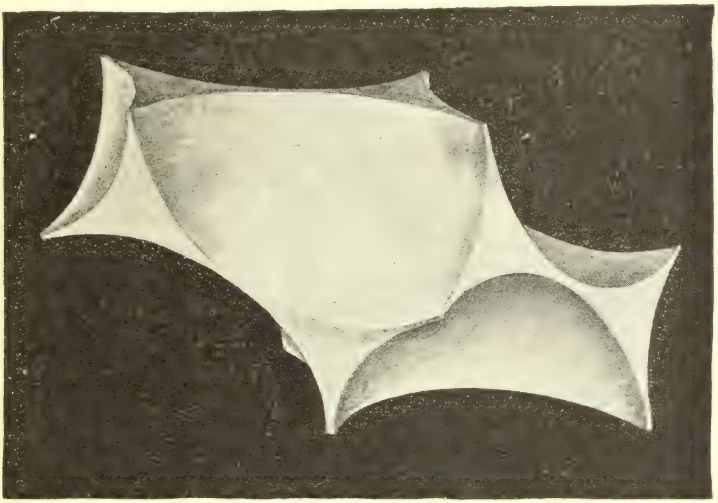


FIG. 5.—Unit element of the pore space in a mass of spheres packed in the most compact manner possible, being a plaster cast of the interior of the solid of fig. 4. By piling up a number of solids like this, with their similar faces in contact, the continuous pores in a mass of spheres would be represented.

exactly spherical in form, but it is true that the length, shape, and number of the pores, and other factors affecting the transmission capacity, are quite similar in a waterworn sand to those found in a mass of shot of proper size. Small variations in the shape of the particles have little or no effect on the result.

MECHANICAL ANALYSIS OF SOILS.

A water-washed quartz sand when viewed under the microscope looks very like a mass of common gravel or a heap of cobblestones. Pl. I, taken from the report of E. R. Buckley, State geologist of Wisconsin, on Wisconsin building stones, illustrates the general appearance very well. Soils and sands which have been deposited by

running water are often well sorted as to size, but in general a naturally occurring deposit is to be regarded as a mixture of grains of a great variety of sizes. It therefore becomes necessary to determine the extent to which grains of the various sizes are present in any sample and to be able to express the results in a convenient way.

The determination of the structure of the soil is known as soil analysis, or, more properly, as the mechanical analysis of soils. In order to compare one soil with another as to its capacity to transmit water, it is necessary to have some way of arriving at a mean or average-sized grain which it is appropriate to associate with each sample. This mean diameter is known as the *effective size*, and is such that if all grains were of that diameter the soil would have the same transmission capacity that it actually has. Hazen's method of determining the effective size consists in first separating or analyzing the sand or soil into several grades by use of sieves of known mesh. The effective size is determined from the dimensions of the mesh of a sieve which will permit 10 per cent of the sample to pass through it, but will retain the other 90 per cent. That is, in any soil, 10 per cent of the grains are smaller than the effective size and 90 per cent are larger.

In order to give expression to the variety of sizes present in a sample, Hazen introduces a number known as the *uniformity coefficient*. To determine this magnitude, first find the size of sand grain which is such that 60 per cent of the material is of smaller grains and 40 per cent of larger grains. This result, when divided by the effective size of soil grain of the entire sample, gives the uniformity coefficient. Thus, if 60 per cent of a sample be finer than 0.62 mm. and 10 per cent be finer than 0.25 mm., the uniformity coefficient is $\frac{0.62}{0.25}$, or $2\frac{1}{2}$. Hazen concludes from his experimental work that the 10 per cent of small grains in a sample of a natural sand or soil has the same influence on the rate of flow of water as the 90 per cent of large grains, provided the uniformity coefficient does not exceed 5.

To illustrate Hazen's method, the analysis and diagram (fig. 6) on the next page are reprinted from his paper in the report of the Massachusetts State board of health for 1892, page 547. A curve similar to the one here reproduced (fig. 6) should be drawn for each analysis, so that the points of crossing of the 10 per cent and the 60 per cent lines can be determined; from the ordinates of these the effective size and the uniformity coefficient are derived.

Weight [of sample], dry, 110.9 grams. It was put into a series of sieves in a mechanical shaker and given 100 turns (equal to about 700 single shakes). The sieves were then taken apart, and the portion passing the finest sieve weighed. After noting the weight, the sand remaining on the finest sieve but passing all the coarser sieves was added to the first and again weighed, this process being repeated

until all the sample was upon the scale, weighing 110.7 grams, showing a loss by handling of only 0.2 gram. The figures were as follows:

Sieve marked.	Size of separation of this sieve.	Quantity of sand passing.	Per cent of total weight.
	Millimeters.	*Grams.*	
190	0.105	0.5	0.5
140	0.125	1.3	1.2
100	0.182	4.1	3.7
60	0.320	23.2	21.0
40	0.46	56.7	51.2
20	0.93	89.1	80.5
10	2.04	104.6	94.3
6	3.90	110.7	100.0

Plotting the figures [in columns 2 and 4], we find from the curve that 10 and 60 per cent respectively are finer than .25 and .62 millimeter, and we have for the effective size, as described above, .25 and for the uniformity coefficient 2.5.

The most promising method of soil analysis for the purpose of determining its transmission capacity is that devised by Professor King.

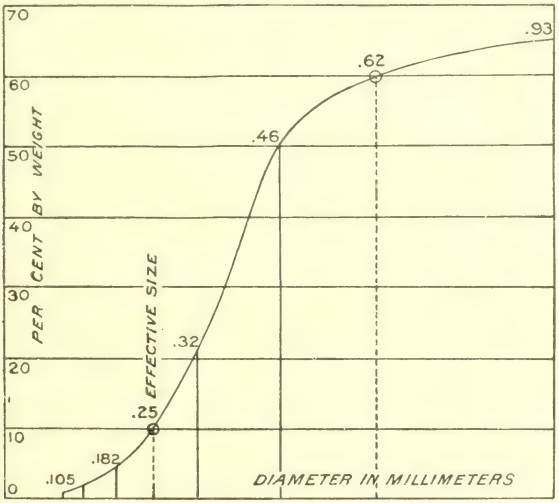


FIG. 6.—Diagram illustrating Hazen's method of making mechanical analyses of soils.

The analysis is accomplished without the use of sieves, by means of an apparatus known as King's aspirator. In this method the effective size is determined by measuring the time required for the flow of a known amount of air through the sample, the measurements being made under a known pressure. It seems that the results yielded by this method are much more concordant than those given by other methods, and the apparatus deserves a thorough test by engineers interested in soil analysis.[a]

[a] A new method for the mechanical analysis of soils, by F. H. King: Fifteenth Ann. Rept. Agr. Exp. Station Univ. Wisconsin, Madison, 1898, p. 123.

THE AUTHOR'S FORMULA FOR DETERMINING FLOW.

The formula which the writer has devised for determining the flow of water through a column of sand is as follows:

$$q=0.2012\,\frac{pd^2s}{\mu hK}\text{ cubic feet per minute.} \qquad (3)$$

In this formula q stands for the quantity of water transmitted by the column of sand in one minute; p is the difference in pressure at the ends of the columns, or the head under which the flow takes place, measured in feet of water; s is the area of the cross section of the sand column, measured in square feet; h is the length of the column, in feet; d is the mean diameter of the soil grains, measured in millimeters, or the so-called "effective size;" μ is the number which takes account of the friction between the particles of water, and is known as the coefficient of viscosity (it is defined as the amount of force necessary to maintain unit difference in velocity between two layers of water unit distance apart; its value, which decreases rapidly with an increase in the temperature of the water, for temperatures from 32° to 100° is given in Table II, below); K is a constant which depends upon the porosity of the sand, and its value for porosities, varying from 26 to 47 per cent, has been computed and is given in Table III, on the opposite page.

TABLE II.

Variation of the viscosity of water, with temperature, and the relative flow of water of various temperatures through a soil, 50° F. being taken as the standard temperature.

Temperature.	Coefficient of viscosity μ.	Relative flow.[a]
Degrees F.		
32	0.0178	0.74
35	0.0168	0.78
40	0.0154	0.85
45	0.0142	0.92
50	0.0131	1.00
55	0.0121	1.08
60	0.0113	1.16
65	0.0105	1.25
70	0.098	1.34
75	0.092	1.42
80	0.087	1.51
85	0.081	1.62
90	0.077	1.70
95	0.073	1.80
100	0.069	1.90

[a] "Relative flow" means flow at given temperature compared with flow at 50° F. It is expressed as a percentage.

TABLE III.

Constants for various porosities of an ideal soil.

Porosity m.	$\frac{1}{K}$.	Log. K.	Diff.	Colog. K.
Per cent.				
0.26	0.001187	1.9258	563	8.0742
0.27	0.001350	1.8695	504	8.1305
0.28	0.001517	1.8191	490	8.1809
0.29	0.001694	1.7701	502	8.2299
0.30	0.001905	1.7199	467	8.2801
0.31	0.002122	1.6732	455	8.3268
0.32	0.002356	1.6277	430	8.3723
0.33	0.002601	1.5847	438	8.4152
0.34	0.002878	1.5409	410	8.4591
0.35	0.003163	1.4999	407	8.5001
0.36	0.003473	1.4592	400	8.5408
0.37	0.003808	1.4193	377	8.5807
0.38	0.004154	1.3816	371	8.6184
0.39	0.004524	1.3445	367	8.6555
0.40	0.004922	1.3078	353	8.6922
0.41	0.005339	1.2725	351	8.7275
0.42	0.005789	1.2374	345	8.7626
0.43	0.006267	1.2029	339	8.7971
0.44	0.006776	1.1690	320	8.8310
0.45	0.007295	1.1370	312	8.8630
0.46	0.007838	1.1058	329	8.8942
0.47	0.008455	1.0729	.....	8.9271

If t stands for temperature of the water Fahrenheit, the author's formula, in which the coefficient of viscosity has been replaced by an expression varying with the temperature similar to that given in the formula of Hazen, may be written as follows:

$$q=11.3\frac{pd^2s}{hK}[1+0.0187(t-32)] \text{ cubic feet per minute.} \qquad (4)$$

It is seen from the above formula that the quantity of water transmitted by a column of sand not only depends upon the length of the column and the head of water as expressed by Darcy's law, but varies in a most remarkable way with the effective size of the soil grain, with the temperature of the water, and with the porosity. Since the flow varies as the square of the size of the soil grain this element in the formula has a most important effect, as doubling the size of the soil grain will quadruple the flow of water. Thus the flow through a sand whose effective size of grain is 1 mm. is 10,000 times the flow through a soil whose effective size of grain is 0.01 mm. The variation of flow with temperature is also important, as the flow at 70° F. is about double that at 32° F. The variation in porosity is quite as important as the variation in temperature.

From Table III it appears that if two samples of the same sand are packed, one sample so that its porosity is 26 per cent and the other sample so that its porosity is 47 per cent, the flow through the latter sample will be more than seven times the flow through the former sample. If the two samples of the same sand are packed so that their porosities are 30 per cent and 40 per cent, the flow through the latter

sample will be about 2.6 times the flow through the former sample. These facts should make clear the enormous influence of porosity on flow, and the inadequacy of a formula of flow which does not take it into account.

Part of the expression on the right side of formula (3) or (4) depends only upon the character of the soil through which the water is passing. Representing this by k we have:

$$k=0.2012\,\frac{d^2}{\mu K}=Md^2, \tag{5}$$

and the formula for the flow becomes

$$q=k\,\frac{ps}{h}, \tag{6}$$

which is essentially Darcy's formula. The constant k is the quantity of water that is transmitted in unit time through a cylinder of the soil of unit length and unit cross section under unit difference in head at the ends. We shall frequently refer to k as the transmission constant, or merely as the constant of a soil.

It should be especially noted that the velocity of flow through a soil for the pressure gradients and size of grain that commonly occur is exceedingly slow, and much less than might at first be supposed. Darton states that the rate of flow in the sands of the Dakota formation, from which the remarkable artesian wells of South Dakota draw their supply, does not exceed a mile or two a year.[a] Mr. E. L. Rogers reported to the Denver society of civil engineers[b] that American estimates agree with careful and exhaustive studies of French engineers, which show the average velocity in sands to be about a mile a year, or about an eighth of an inch a minute. In Arizona the rate has been figured out as between one-fourth and one-third of an inch per minute, while on Arkansas River above Dodge, Kans., a ditch a mile long and 5 feet below the water table in the sand developed a flow of about three-eighths inch per minute.

---

[a] New developments in well boring and irrigation in eastern South Dakota, by N. H. Darton: Eighteenth Ann. Rept. U. S. Geol. Survey, Part IV, 1897, p. 609.

[b] Engineering Record, Vol. XXV, p. 4351.

TABLE IV.

Velocity of water in sands of various effective sizes of soil grain and the maximum flow or transmission constant for each soil.

[Porosity, 32 per cent; temperature, 50° F. Results for other porosities can be found by the use of Table V, and for other temperatures by the use of Table II.]

1.	2.	3.	4.	5.	6.	7.
Diameter of soil grain.	Velocity, pressure gradient 1:1.	Velocity, pressure gradient 1:1.	Velocity, pressure gradient 100 feet to 1 mile.	Maximum flow, or transmission constant, *k*.	Logarithm of numbers in column 5.	Kind of soil.
Mm.	*Ins. per min.*	*Miles per year.*	*Miles per year.*	*Cu. ft. per min.*		
0.01	0.0014	0.0113	0.00026	0.000036	5.5569	
0.02	0.0054	0.0452	0.00102	0.000144	6.1590	Silt.
0.03	0.0122	0.1016	0.00230	0.000324	6.5111	
0.04	0.0218	0.1807	0.00408	0.000577	6.7610	
0.05	0.0340	0.2823	0.00638	0.000901	6.9548	
0.06	0.0490	0.4065	0.00918	0.001298	7.1132	
0.07	0.0667	0.5534	0.01250	0.001766	7.2471	Very fine sand.
0.08	0.0871	0.7223	0.01633	0.002308	7.3631	
0.09	0.1103	0.9147	0.02066	0.002920	7.4654	
0.10	0.1361	1.129	0.02551	0.003605	7.5569	
0.12	0.1961	1.627	0.03674	0.005192	7.7153	
0.14	0.2668	2.213	0.05011	0.007065	7.8491	
0.15	0.3063	2.541	0.05753	0.008112	7.9091	Fine sand.
0.16	0.3485	2.892	0.06382	0.009228	7.9651	
0.18	0.4412	3.659	0.08266	0.01168	8.0675	
0.20	0.5446	4.518	0.1021	0.01442	8.1590	
0.25	0.8509	7.058	0.1594	0.02253	8.3528	
0.30	1.225	10.16	0.2296	0.03244	8.5111	
0.35	1.668	13.84	0.3125	0.04417	8.6451	Medium sand.
0.40	2.178	18.07	0.4081	0.05768	8.7610	
0.45	2.757	22.87	0.5165	0.07300	8.8633	
0.50	3.403	28.23	0.6377	0.09012	8.9548	
0.55	4.119	34.17	0.7718	0.1090	9.0377	
0.60	4.901	40.65	0.9183	0.1298	9.1132	
0.65	5.751	47.81	1.077	0.1523	9.1827	
0.70	6.671	55.34	1.250	0.1766	9.2471	Coarse sand.
0.75	7.660	63.53	1.435	0.2028	9.3071	
0.80	8.714	72.28	1.633	0.2308	9.3631	
0.85	9.835	81.57	1.843	0.2604	9.4157	
0.90	11.03	91.47	2.066	0.2920	9.4654	
0.95	12.28	101.9	2.302	0.3253	9.5123	
1.00	13.61	112.9	2.551	0.3605	9.5569	
2.00	54.46	451.8	10.21	1.442	0.1590	
3.00	122.5	1,016	22.96	3.244	0.5111	Fine gravel.
4.00	217.8	1,807	40.81	5.768	0.7610	
5.00	340.3	2,823	63.77	9.012	0.9548	

Table IV, above, gives the velocity of movement of water in sands of various grades for different pressure gradients. Column 1 gives the effective size of the soil grains in millimeters. As already stated, this size is such that if all grains were of that diameter the soil would have the same transmission capacity that it actually has. Column 2 gives the velocity of flow, or the rate at which the water moves through the ground in inches per minute under a pressure gradient of 1 foot difference in head to each foot of distance. Column 3 gives the velocity of flow reduced to miles per year, the pressure gradient being the same as in column 2. Column 4 gives the velocity of flow in miles per year under a pressure gradient of 100 feet to the mile. The velocity for a pressure gradient of 10 feet to the mile would be one-tenth of the numbers in this (fourth) column, and so on for other gradients. Column 5 gives the actual discharge in cubic feet per minute for each square foot of cross section if the pressure gradient be 1 foot difference in head for each foot of distance. For a pressure

gradient of 1 foot difference in head for each 100 feet of distance, the flow per square foot will be 0.01 of the tabulated numbers, and so on for other gradients. The numbers in this (fifth) column have also been called the "transmission constants," and have been represented in the formulas by k.

TABLE V.

Relative flow of water through sands of same effective size grain, but packed so as to possess different porosities.

Porosity, or per cent of voids.	Relative flow.[a]
30	0.81
32	1.00
34	1.22
36	1.47
38	1.76
40	2.09

[a] "Relative flow" means flow for the given porosity compared with flow for porosity 32 per cent as standard. It is expressed in the table as a percentage of the flow for a sample having a porosity of 32 per cent.

MAXIMUM FLOW.

Inasmuch as the flow of ground water is nearly always caused by a difference in head due to gravity only, the maximum flow that is pos-

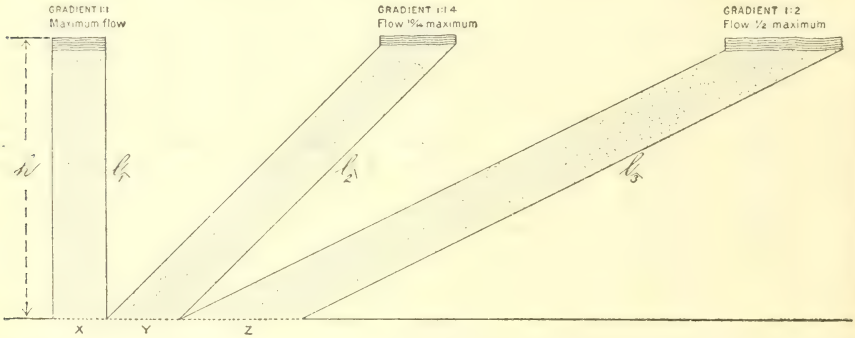


FIG. 7.—Diagram illustrating various pressure gradients and the maximum flow. In these three cases the upper portions of the soil columns are supposed to be supplied with water as fast as it can flow through the columns. The escape at X, Y, Z is supposed to be perfectly free. The head under which the flow takes place is h, in each case, as shown at the left of the figure. The various lengths of the soil columns, l_1, l_2, and l_3 produce the pressure gradients $h/l_1 = 1$; $h/l_2 = \frac{1}{1.4}$; and $h/l_3 = \frac{1}{2}$, respectively, with the resulting flows in proportion if the material in the various columns be the same.

sible is found in the case in which the ground water is free to move in a vertical direction, as in a perfectly underdrained sand-filter bed. The motion in this case is due to the weight of the water of saturation, and the flow is of course greater than would be the case if the water were obliged to flow in a direction inclined to the vertical, instead of in the vertical direction as supposed. These facts are illustrated in fig. 7. The flow in the case of pressure gradient 1:1 forms a most convenient basis for calculation, and it is frequently called, as suggested by Hazen, the maximum flow. The flow for any other gradient is immediately calculable from the maximum flow—for a

gradient 1:100 the flow being, of course, one one-hundredth of the maximum flow.

The appropriateness of the term maximum flow is illustrated by fig. 8, which shows the original water table and the depressed water table due to the construction of a drainage ditch. It is plain that the pressure gradient for all of the streams of flow marked by arrow heads is less than the gradient 1:1. If the wetted area of the ditch be multiplied by the maximum flow for the kind of material in which the ditch has been excavated the flow thus computed will in every case exceed the flow actually determined by measurements of the yield of the ditch.

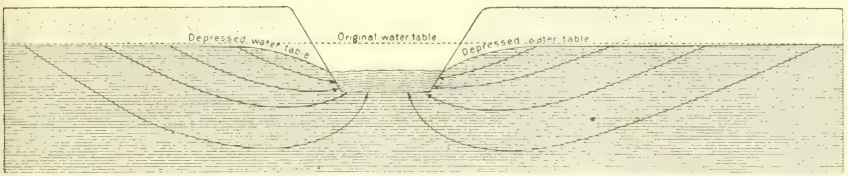


FIG. 8.—Diagram showing lines of flow into a drainage ditch and the shape of the water table in its neighborhood. The head under which the flow takes place is the difference in height of the original water table and the level of the surface of the water in the ditch. This is much less than the lengths of the curved lines of the flow into the ditch, hence the rate of flow must be much less than the so-called maximum flow.

There is not uniformity in the use of the term velocity as applied to the motion of ground waters. We use the term to express the rate (measured as so many feet a day, etc.) at which the water advances through the porous medium, irrespective of the amount of water thus advancing. The amount of ground water (measured in cubic feet per minute, etc.) passing through a given cross section the writer has called the flow or the discharge. It is equal to the velocity multiplied by the porosity. Some measure velocity as a rate of motion in a solid column of same area as the cross section of the porous medium. This is the same magnitude which we have called flow.

In using Table IV one should use the numbers in columns 2, 3, or 4 if the velocity of ground water is wanted, but should pass to column 5 if the flow or yield is required. Thus, suppose it is desired to find the rate of motion of ground water through a bed of sand which slopes 10 feet to the mile. The results can be found for various materials and grades of material by dividing the numbers in column 4 by 10, since a slope of 10 feet to a mile will cause but one-tenth of the velocity existing for a slope of 100 feet to a mile. For materials of various grades we obtain the following results:

Velocity of ground water in materials of different grades, pressure gradient 10 feet per mile.

Material.	Miles.	Feet per year.
Fine sand, 0.2 mm. diameter	0.010	52.8
Medium sand, 0.4 mm. diameter	0.041	216.0
Coarse sand, 0.8 mm. diameter	0.16	845.0
Fine gravel, 2 mm. diameter	1.02	5,386.0

Suppose that it is desired to ascertain the amount of water that will pass through a bed 200 feet deep and 1,000 feet wide, having the same slope as that just mentioned. This problem requires us to find the flow, and the numbers used in the computation should therefore be taken from column 5 of Table IV. The flow for 1 square foot of cross section of the bed will be $\frac{10}{5280}$ of the maximum flow given in that column for material of various grades, and the total flow is found by multiplying the maximum flow by $\frac{10}{5280} \times 200 \times 1{,}000$, which gives the following results for the same materials described in the preceding table:

Flow of ground water in materials of different grades through a bed of vertical cross section 200 by 1,000 feet, sloping 10 feet per mile.

	Cu. ft. per min.
Fine sand	5.5
Medium sand	22.0
Coarse sand	87.0
Fine gravel	546.0

The estimates in Table IV were based upon a porosity of 32 per cent. For other porosities the results must be changed by the percentages shown in Table V. Thus all of the results just found must be increased by about 37 per cent if the porosity of the material be 35 instead of 32 per cent.

CHAPTER II.

SURFACE ZONE OF FLOW OF GROUND WATERS.

Most people obtain their ideas of underground streams of water from the descriptions of the underground torrents in the Mammoth and other caves. Such notions, however, are erroneous. The rivers found in caverns are almost exclusively peculiar to limestone or calcareous formations and are not typical of subterranean streams. The underground drainage of calcareous rocks is, nevertheless, of great interest. The well-known solvent action of rain water percolating through limestone has no more beautiful demonstration than the existence of caverns like the Mammoth Cave, with its scores of miles of ramifying passages and its enormous vaulted chambers. As is well known, these galleries and passages represent the channels of former subterranean streams which for the most part have now found escape at lower levels. Maps of such caves show that the passages are arranged somewhat like the branches of a tree—very similar, indeed, to the divisions and subdivisions of surface drainage as represented by the main river, the lesser rivers, and the tributaries.

As a rule, the running streams of limestone caverns, as well as those found in the seams, joints, fissures, etc., of crystalline and other rocks, join the surface-drainage system before they have attained any considerable size. Therefore large cavern streams are very rare, and when discovered they have attracted wide attention. The Echo River of the Mammoth Cave, one of the largest and best known of this type, is from 20 to 200 feet wide and from 10 to 40 feet deep. Sometimes little can be directly observed of a subterranean stream except the enormous spring which marks its mouth. The famous Wyandot Spring, near Columbus, Ohio, representing the drainage of a considerable area collected into ramifying passages in the Corniferous limestone, is a good example of this type, as are also the enormous fresh-water springs in the ocean off the coast of Florida.

Pl. II shows a sink hole connecting with an underground drainage system, and an underground channel, as observed by Mr. Willard D. Johnson on the southwestern plains. The writer is indebted to Mr. Johnson for the photographs.

Putting the subterranean streams of the limestone type into a class by themselves, there remain the great systems of underground drainage represented by the slowly percolating waters of sand and gravel deposits, sandstones, and other porous materials. It is this class of

subsurface drainage that we must regard as the important one, both because of its actual areal extent and because of its economic importance as a possible source of water supply. It is the water of this type of underground drainage that is properly designated ground water or underground water, the running water of crevices and caverns rarely being uppermost in mind when this term is used.

Underground waters may be divided into three principal zones: (1) The unsaturated zone; (2) the surface zone of flow; and (3) the deeper zones of flow.

The motion of water in the unsaturated zone is essentially in a vertical direction, downward, supplying the saturated sheet below it in times of rainfall, and upward supplying the surface evaporation and the requirements of vegetation by means of the capillary action of the soil during rainless periods. A special discussion of this zone of ground waters does not come within the scope of this paper, and is therefore omitted.

The surface or upper zone of flow extends from the level of the water table to the first impervious material of general extent reached by the underground water in its downward percolation.

The deeper zones of flow are those that lie below the first impervious stratum. There may be several zones falling within this class. In these zones the direction and character of the flow are usually quite independent of surface topography and are almost entirely controlled by large regional and geologic conditions. Special consideration of the deeper zones of flow will be postponed to a later chapter of this paper.

UNDERGROUND DRAINAGE BASINS.

The unit of the surface zone of flow of ground waters is the river valley. In the surface zone the rate and direction of motion of the underground water conforms primarily to the slopes and grades of the land surface. The effective principle in the surface zone is that underground flow follows the trend and direction of the surface drainage. The direction taken by the surface waters in their course into streams and drainage channels is in general the same as that taken by the seepage waters of the upper zone of flow. As previously pointed out, actual determinations usually show that the water table has a slope which is essentially similar to the slope of the surface of the ground, differing from the latter principally in being less steep. The surface divide or watershed usually coincides with the line of the underground water divide or watershed, and the motion of the underground seepage into the streams and rivers is similar to the lines followed by the surface drainage into the same streams.

The lowest line of drainage of the valley is known technically as the thalweg. Topographically it is a line upon a contour map which is a natural water course. Beneath the thalweg there is usually a similar drainage line for the underground current, in general coincident

A. SINK-HOLE CONNECTION WITH UNDERGROUND DRAINAGE SYSTEM.

B. UNDERGROUND CHANNEL.

with the thalweg. For other parts of the valley the actual lines of motion of the underground water are represented by a set of curves which cut the contour lines of the water table at right angles, as shown in fig. 9. The similarity of the contours of the water table to those of the land surface enables one to sketch approximately the lines of underground seepage from a contour map of the surface.

For the most part the lines of flow run into the surface streams or thalwegs, but between A and B and X and Y there is indication of an underflow or general movement in the direction of the surface streams and independent of the same.

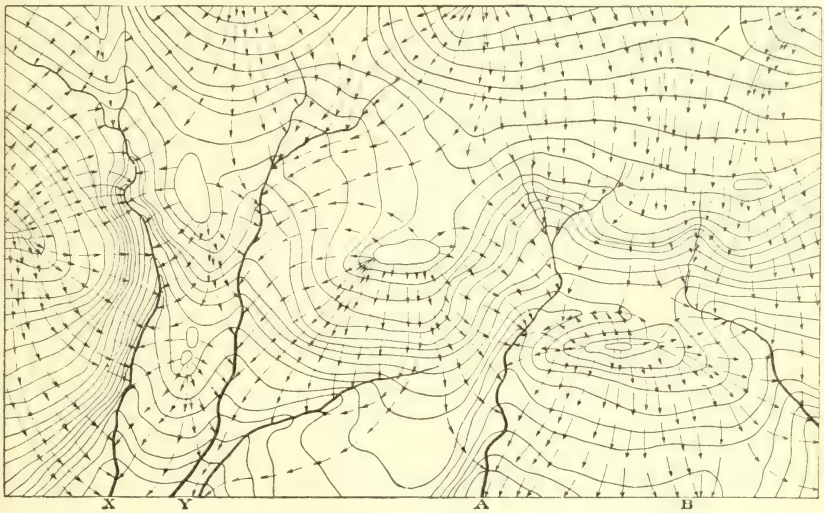


FIG. 9.—Contour map showing position of water table (continuous lines), supposed lines of motion of ground water (arrowed lines), and the thalwegs or drainage lines (heavy lines).

It is claimed by Chalon,[a] a French engineer, that the subterranean thalweg on the main line of underground drainage is usually nearer the steeper side of the valley than is the surface stream. (See fig. 10.) Such principles are emphasized in foreign treatises, but American experience has not found them of great value.

SHAPE OF THE WATER TABLE.

The similarity between the contours of the land surface and the contours of the water table just explained must not be taken too literally. The coincidence of the surface and subterranean thalwegs and of the surface and subterranean watersheds is a common occurrence, but is not a geologic necessity. In itself the surface topog-

[a] Sur la recherche des eaux souterraines: Mém. Soc. ingénieurs civils de France, 1897, Vol. II, p. 38. See also L'Art de découvrir les sources, by L'Abbé Paramelle, fourth ed., Paris, 1896, p. 138.

raphy is only one, and often not the most important, element in the control of the underground current.

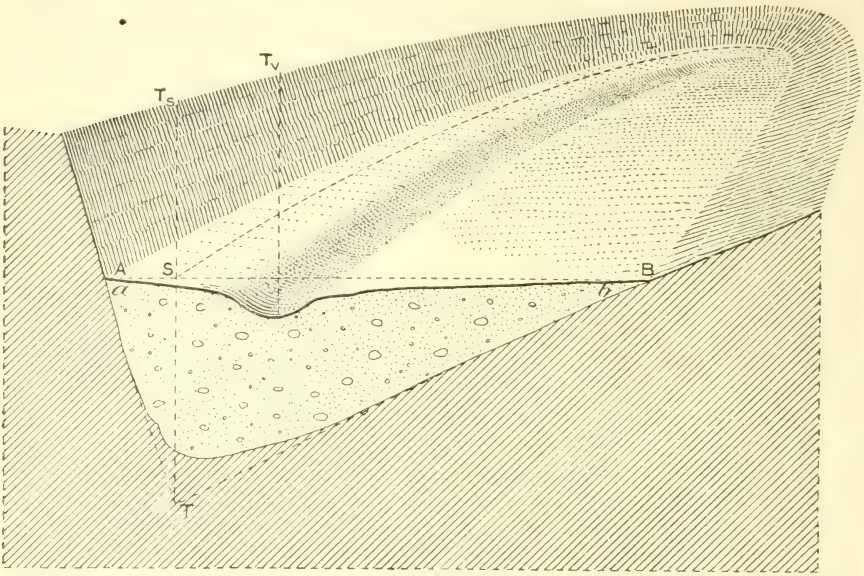


FIG. 10.—Diagram illustrating Chalon's principle that the main core of the underground drainage, or subterranean thalweg, naturally lies nearer the steeper side of the valley than does the surface stream. The surface stream is at T_v and the subterranean thalweg at T_s.

The horizontal distribution and motion of the ground water is influenced first of all by the form of the surface of the impervious layer.

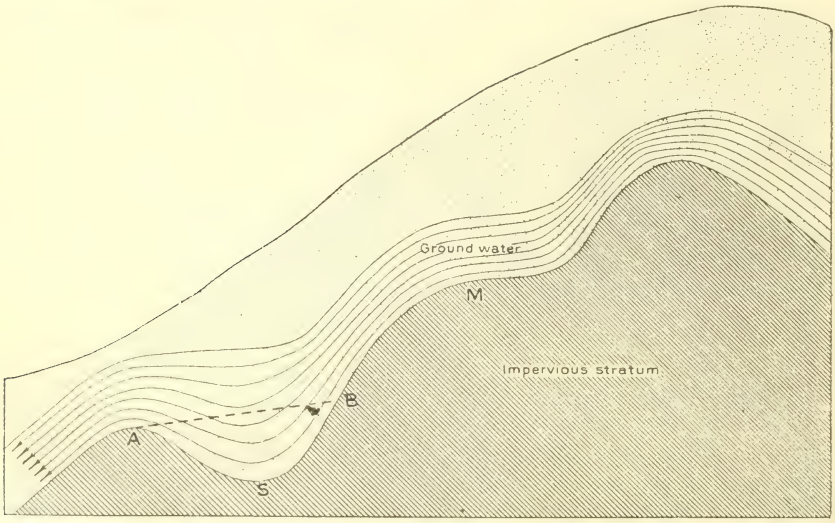


FIG. 11.—Diagram illustrating lines of flow of ground water over a series of monoclines, synclines, and anticlines, as at M, S, and A, respectively.

It is also influenced in a marked degree by the varying altitude of the surface or receiving area, by the character of the pervious layer, by the

altitude and distance of the nearest thalweg or drainage channel, and finally by the amount of the rainfall. These elements acting together in a region determine the depth of the water table below the surface and the direction and rate of motion of the underground current. They form a complicated system, and it is not easy to describe the precise part which each plays in a given case. Fine material and large rainfall tend to make the ground water stand high within the hills and elevated places and to give steep gradients to the water table. Likewise coarse material and light rainfall tend to a low water table and to light gradients. From these considerations it is obvious that the form of the impervious stratum affects the water table much less in humid climates than in semiarid or arid climates.

It is also important to remember that synclines in the impervious material (as at S, fig. 11) crossed by the lines of motion of the ground

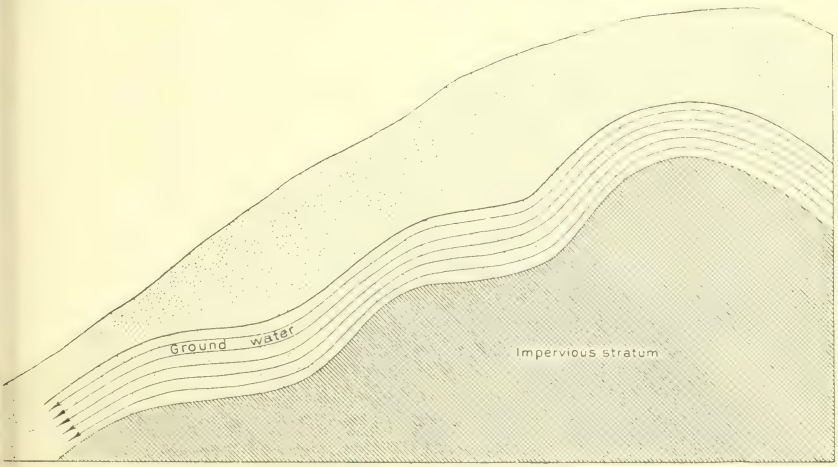


FIG. 12.—Diagram illustrating lines of flow of ground water over a series of monoclines in an impervious bed.

water have no effect on the form of the water table. However, if the lines of motion follow a syncline instead of crossing it, the water table also will probably have a synclinal form, although less pronounced than that of the impervious layer. Monoclines in an impervious floor crossed by moving ground water will give a similar form to the water table, as shown in fig. 12. We may normally expect, then, that the water table in the direction of the lines of motion will be a series of monoclines, as shown in figs. 1, 11, and 12, with only occasional deviations during periods of rainfall.

The motion of the ground water as a whole is somewhat like the slow motion of a very viscous sirup or the slowly creeping ice of a glacier. These comparisons, however, are likely to be misleading. In the slow motion of a viscous liquid the bounding layer sticks fast to the walls of the vessel containing the liquid, so that motion nearly

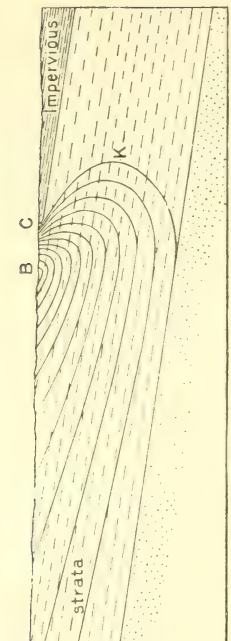


FIG. 13.—Diagram illustrating lines of motion of ground water in an outcrop of a pervious bed underlain and overlain with impervious strata. The diagram represents a vertical section taken along the dip of the strata. The area from A to B is a receiving area, which absorbs the rainfall. From B to C is an area of outflow or of returning ground waters. The pervious bed is supposed to have no drainage to the right of the limits of the figure, so that all return seepage must take place around the edge, C, of the impervious cover. The diagram was drawn by the author to illustrate the paths of the ground waters which have deposited the ores in the Mesabi iron range.

ceases in the neighborhood of the boundary. This is not the case, however, in the movements of ground waters, as the frictional resistance which the water meets is present in each individual pore between the soil particles, and is not transmitted from layer to layer through the water itself, as in the case of a viscous liquid. If the material is no finer near the impervious layer or boundary the resistance to motion per unit length is no greater at the boundary of the region than in its interior. This uniform distribution of the resistance to motion throughout the mass of the ground water, and the separation of each individual stream in a capillary pore from every other similar stream in the neighboring pores makes the character of the motion difficult to understand. The motion of water in pipes canals, and surface streams is an exceedingly poor and a very misleading analogy. If it were not for the ever present controlling influence of gravity the motion would be entirely analogous to the flow of heat or electricity in a conducting medium, as the writer has shown in another paper.[a]

A remarkable conclusion from the paper just cited is that ground-water motions resemble in general character the motions of a "perfect" or frictionless liquid under similar conditions but with the porous medium entirely absent. The chief difference lies in the fact that in the case of a perfect liquid gravity produces a rapidly accelerated motion, the energy represented by the increase in the motion being the equivalent of the work done by the external forces (gravity) while in the case of the motion of the water in the pores of the medium

[a] See Chapter II of Theoretical investigation of the motion of ground waters: Nineteenth Ann. Rept. U. S. Geol. Survey, Pt. II, 1899, p. 295.

most of the energy contributed by the work of the external forces is transformed into heat by the enormous friction in the capillary spaces. Thus in fig. 12 the velocity along the various lines of flow, represented by the continuous curves with arrowheads on them, is substantially the same for each line, since they are of practically the same length. The water flows along them just as heat would flow along a conducting material of the same shape. Likewise in fig. 11 the velocity along the lower lines of flow is somewhat less than along the upper lines, for the lower lines have the greater length. Again we may imagine that the ground water flows along them just as heat would flow along a conductor of similar shape, unless the ground water is about to escape to the surface drainage, as at S in figs. 25 and 26; in this case the effect of gravity is to give relatively high velocities to the water lying next to the impervious floor. The writer has shown that the velocities and lines of motion can be calculated for such cases, some results being shown in figs. 14 and 15.

The contention of some German hydrographers that there can be no motion[a] in a region like ASB in fig. 11 must be entirely abandoned. The water must circulate in all parts of the enlargements in the porous medium, for the same reasons that heat would be conducted

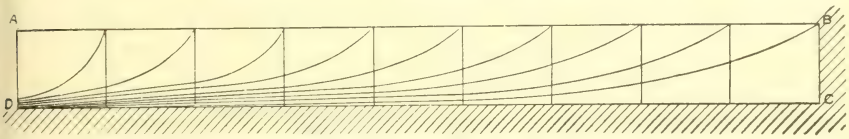


FIG. 14.—Diagram showing seepage lines in a pervious bed resting upon an impervious floor. A, B, C, D is a vertical section. Rain falls upon the surface AB and finds free escape at the surface AD. The curved lines show the paths along which the seepage takes place. The effect of gravity is to draw these lines close together near the impervious floor.

over similar enlargements in a conductor. All lines of motion must begin and end in the boundaries of the water-bearing medium, and must entirely traverse and completely occupy all enlargements in the porous strata.

As already indicated, the general trend of the moving underground water, under the influence of gravity, is into the neighboring streams and lakes. This motion must be materially modified by many causes, which frequently present most complex combinations. While the return flow of ground water to the water courses by means of diffused and almost imperceptible seepage is the rule, yet we must remember that geologic conditions may be such—for example, the outcropping of an impervious stratum—as to force the water table above the surface of the ground and converge and concentrate the lines of flow into a strong current. In the latter case we have the phenomenon of the flowing spring. Ground water returning to the surface in the form of springs so quickly attracts observation

[a] Otto Lueger, Wasserversorgung der Städte, p. 127.

that the more important but less obvious return in the form of diffused seepage almost entirely escapes attention.

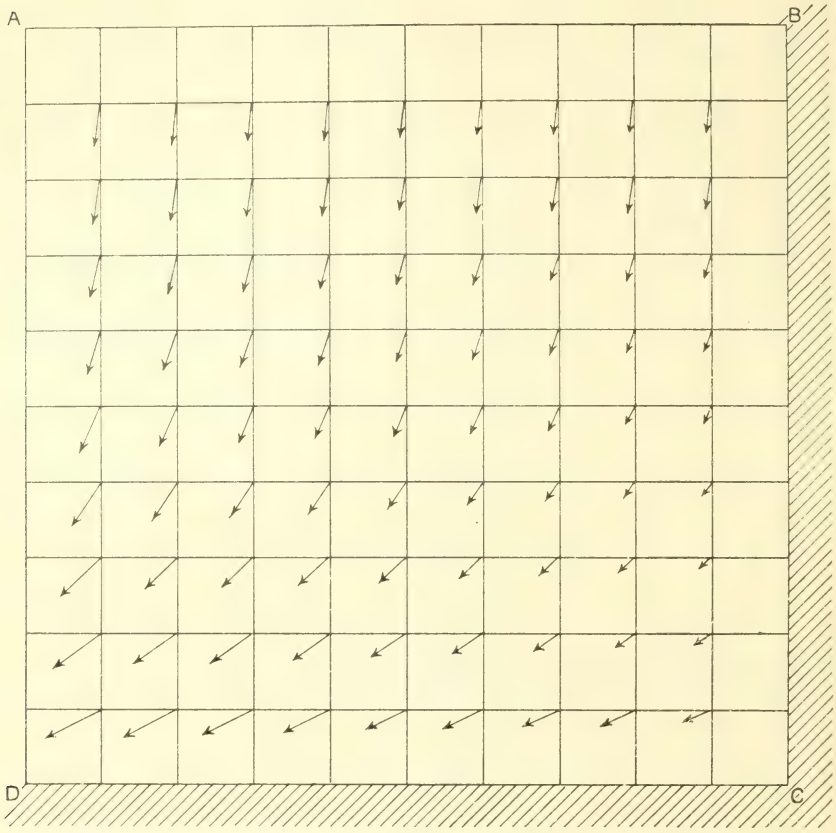
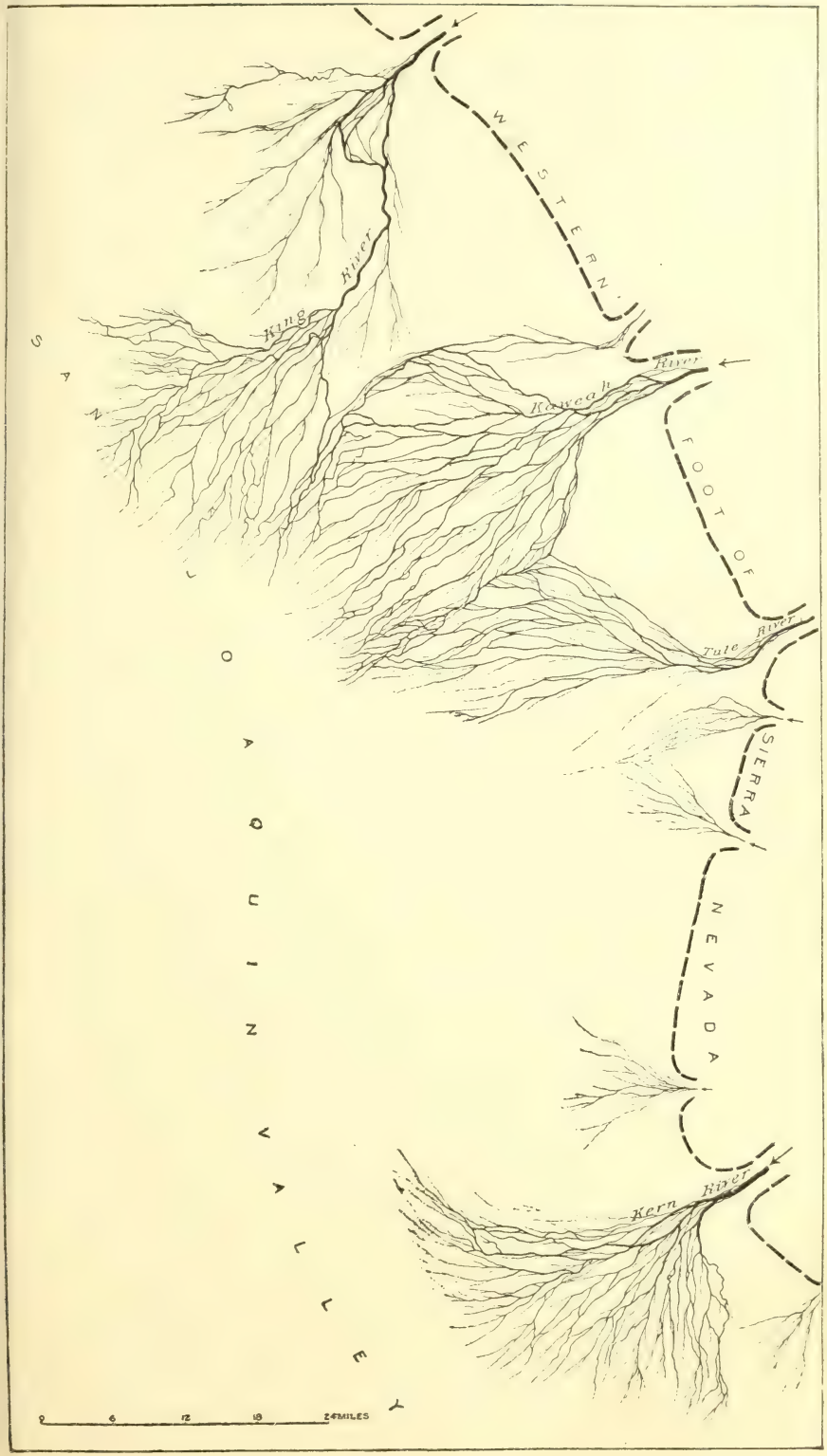


FIG. 15.—Diagram showing direction and rate of seepage in a pervious bed resting upon an impervious floor. The directions and lengths of the arrows show, respectively, the direction and the velocity of motion at various points in the pervious bed. Rain falls upon AB and escapes at AD, as in fig. 14.

THE UNDERFLOW.

The ground water after starting on its journey toward the river valley may not after all find its way immediately into the channel. Sometimes it takes a general course down the thalweg and toward the sea within the porous medium itself. This movement may be so great as to constitute a large underground stream, scores of feet in depth and miles in breadth.

The moving sheet of water beneath the bed and banks of a stream is the underflow, properly so called. This term is also extensively used in the West to designate the nearly stationary ground water of the Great Plains. It originated with those who formerly believed that there was a great sheet of water beneath the surface of the Plains, originating in the melting snows of the Rocky Mountains and flowing rapidly through the subsoil toward Missouri River and the sea.



MAP SHOWING THE DELTAS OR FANS OF DISAPPEARING STREAMS AS THEY LEAVE

It is evident that a considerable underflow is impossible with material as fine as is sometimes found filling the valleys of rivers. Such material may play a very important part in the storage of water, but it can not be an important element in its transportation over great distances. An entirely different condition may exist where the sands and gravel beneath the stream are sufficiently coarse, as is likely to be the case near the source of streams in the mountains. Here the material deposited by the stream is the coarser sands, gravel, and bowlders brought down by the mountain torrents. The running water will not deposit the finer material until the stream bed reaches a gentle slope and the current has lost its high velocity. The periodic floods sweeping down the mountain sides during the heavy rains soon fill the river canyons with coarse débris, on the surface of which the perennial stream has its bed. Below the bed of the stream there is a vast body of water slowly percolating through the coarse material. Occasionally as we pass down the stream we may find the rock walls of the canyon nearer together, or perhaps the bed rock beneath the débris is closer to the surface, the result in either case being a marked augmentation of the amount of water in the river, because the percolating waters of the underflow are forced to the surface and mingle with the waters of the surface stream.

At the mouth of the canyon the valley broadens out and the bed rock sinks more deeply beneath the surface of the land, while the stream deposits more and more of its suspended matter. The underflow may also broaden and deepen to fill the greatly enlarged channel, the finer material and lesser slope decreasing the speed with which it flows down the valley. The valley may be now so broad that if the rainfall be copious the constant increments to the underflow from seepage of the rainfall from the higher land must give rise to regular flow of the subsurface waters into the perennial stream itself, causing its constant growth during its course toward the sea. On the other hand, if the stream issues from its mountain canyon in an arid region the surface stream may gradually disappear, until a dry wash through the valley, only occasionally swept with floods from the mountains, marks the general course pursued by the silent underflow.

Numerous instances of the disappearance of mountain streams occur in the arid regions of the West. There are many interesting cases along the Coast Range in California, two of which are shown on the Cucamonga topographic atlas sheet of the Geological Survey. From that map will be seen the way in which the disappearing streams fan out into numerous branches, which are very appropriately called, from analogy, the deltas of the rivers. In Pl. III are shown the distributing deltas of King, Kaweah, and Kern rivers, California, as they enter San Joaquin Valley from their canyons in the western edge of the Sierra Nevada. There can be no question that the underflow in this case follows the general trend indicated by the surface branches.

It has been pointed out how the broadening of the valley, as a stream flows out of its mountain canyon, will have effects entirely opposite, depending upon whether the climate of the valley be arid or humid. If the climate be arid the broadening of the valley will expose the underflow to increasing evaporation during its slow movement in a broad belt, while if the climate be humid the broadening of the valley will greatly increase the collecting area of the rainfall and constantly contribute a part of the underflow to the water of the river itself. In one case the broadening of the valley is the occasion of the constant diminution of the volume of the river; in the other case it is the occasion of the constant growth of the river.

The relation of the underflow to the waters of the river channel presents many interesting phenomena and variations. In some cases silt may have rendered the channel of the river so impervious that for considerable distances little interchange can take place between the river waters and the underflow waters. This sealing effect of river silt is illustrated in an attempt by Nettleton to measure the velocity of the underflow of the Rio Grande.[a] The plan was to sink holes in a sandbar a little below the water line, with the expectation that the water would rise in them to the level of the river surface. It was then proposed to note the time it took a colored liquid to travel from one hole to the next one downstream. But even on this island, surrounded by water and still under water a few days prior to the experiment, and to all appearances composed of the same material as the river bed and its banks, they did not succeed in finding water 3 feet below the surface. The holes were within a foot of the river and yet no water came into them within twenty-four hours.

That underflow waters are sometimes quite independent of the water flowing in the surface stream is abundantly shown by the experience of German water-supply engineers. B. Salbach cited some interesting examples before the engineering congress at the Chicago World's Fair in 1893.[b] In 1867 Salbach was called to report upon the preliminary works then under way for testing the sources of supply of the city of Halle. These works consisted of borings in the Aue, near Beesen, above the junction of the Elster and the Saale, in a thick and widely extended bed of gravel, and in pumping large quantities of water from a well which a chemical analysis had shown to be suitable for the proposed supply.

It had been assumed, before undertaking the examinations, that the water from the neighboring rivers had penetrated this bed of gravel. That this assumption was erroneous was speedily proved. In the first place, the water taken from the gravel was shown to have

[a] See Final Report of Chief Engineer E. S. Nettleton: Ex. Doc. 41, Pt. II, Fifty-second Congress, first session, p. 35.

[b] Experiences had during the last twenty-five years with waterworks having an underground source of supply, by B. Salbach, Baurath at Dresden, Saxony: Trans. Am. Soc. Civil Eng., Vol. XXX, 1893, pp. 293-329.

an entirely different chemical composition from that of the river water, the water from the gravel being harder than that taken from the river, while the water of the Saale gravel was still harder than the water of the Elster gravel. In the next place, it was shown by a series of experiments that a natural filtration of the river water was wholly impossible. To prove this several wells were dug along the shore of the river, and the ground-water level in them was reduced, by pumping, about 4 feet lower than the river level. When this was done the earth over the whole water level on the river side was entirely dry. Extending the well laterally until within about 14 inches of the bank of the river caused no flow of water from the bed of the river into the well, this last 14 inches of soil being dense and impervious. These examinations proved that in this case at least there was no flow of water from the river into the bed of gravel of the valley, and that the water drawn from the wells was an independent underground source of supply which flowed parallel to the river through the gravel and followed the general slope of the valley.

Salbach also gave an account of the water-bearing gravels of the valley of the Elbe. Several bore holes put down on the right bank of the Elbe showed a steep slope of the water table at right angles to the river. The ground water taken from these holes was found to be exceedingly pure and of an appreciably less degree of hardness than the water of the river. Borings on the left bank showed a less slope of the water table at right angles to the river, while the samples of water taken from the borings were pure, but somewhat harder than the water of the Elbe. Borings put down in the river itself to a depth of from 23 to 26 feet showed that the ground water rose in the bore holes 6 inches above the level of the river, while the water was softer than the river water. It is a remarkable fact that the ground water in almost the entire valley of the Elbe is softer than that of the river.

RATE OF MOVEMENT OF THE UNDERFLOW.

The magnitude of the underflow depends, obviously, upon many important factors. One of these is the average gradient of the river valleys. Others are the depth, width, and composition of the beds which constitute the alluvial deposits of the stream. The fineness of this alluvium is of special importance. An inspection of Table IV (p. 27) will show that a coarse sand or gravel will permit an underflow of considerable magnitude. On the other hand, a fine material will render the underflow quite insignificant.

Direct observations of the rate of motion of the underflow are almost completely lacking in this country. A number of indirect observations of various kinds enable us, however, to form an idea of the possible rates under special circumstances. One of the highest determinations of the rate of underflow is that made by Hicks for Loup

River in Nebraska.[a] In the region considered September is a relatively dry month, much drier than August. The maximum rainfall usually occurs about the middle of July. Notwithstanding the marked decline in precipitation, and quite independent of the state of the weather at the time, the Loup rivers generally rise in September. The increase in volume is slight, yet perceptible, and, occurring in a dry month, can not be explained by contemporary causes. Hicks believes the rise to be due to the July rainfall upon the neighboring undrained areas, which amount to about one-third of the entire basin. The percolating waters reach the rivers about two months after they have fallen as rain, and estimating the average distance traversed by the subterranean water as 20 miles, Hicks computes the rate of flow to be about one-third of a mile per day. This rate of flow is so enormous, as can be seen by reference to the fourth column of Table IV, that the explanation must be defective. Possibly the phenomena may be explained by the lesser evaporation of September.

More satisfactory conclusions as to the rate of the underflow may be deduced from the measurements of seepage reported by Professor Carpenter.[b] Estimates based upon the seepage from the Fort Morgan canal and a new section of the same canal gave for the first a velocity of about 3 feet a day and for the second a velocity of about 15 feet a day. Water Commissioner J. T. Hurley reports to Carpenter that the seepage from the Weldon Valley canal has progressed 1½ miles in five years. N. C. Alford reports that in one case, under the Larimer County canal, it was five years before seepage showed at a distance of 40 rods from the canal, though the slope was considerable. In one case, near Greeley, according to Mr. S. A. Bradfield, it seems to have taken about ten years for the water to move 2½ miles.[c]

C. E. Grunsky has measured the seepage loss in King River and the Fresno canal, California,[d] and found that the losses for various sections of the canal were 3.77, 3.48, and 1.25 second-feet per mile. The average velocities of seepage through the canal bed, calculated on a basis of average width of 40 feet and a porosity of 33 per cent, are, respectively, 4.8, 4.3, and 1.6 feet per day. According to the same authority the losses on various portions of the Fresno canal were 8.49, 0.74, and 0.95 second-feet per mile. The average velocities of seepage, calculated on a basis of width of canal bed of 50 feet, are, respectively, 8.4, 0.7, and 0.1 feet per day. The average losses on a 6-mile and a 1-mile section of the Centerville and Kingsbury canal were, respectively, 15.63 and 52.35 second-feet per mile. These figures lead, on a basis of canal width of 50 feet, to the enormous seepage velocities of 16 and 52 feet per day, respectively. For a number of miles this

[a] On the underflow and sheet water, etc., by L. E. Hicks: Ex. Doc. 41, Pt. III, Fifty-second Congress, first session, Washington, 1892, p. 187.

[b] Seepage or return waters from irrigation: Bull. Colorado Agr. Exp. Sta. No. 33, p. 45 et seq.

[c] Op. cit.

[d] Irrigation near Fresno, Cal., by C. E. Grunsky: Water-Supply and Irrigation Paper U. S. Geol. Survey No. 18, 1898, pp. 76, 77.

canal is within several hundred yards of the edge of the descent to the bottoms, which lie from 20 to 30 feet below the surface of the upland. This location in porous soils and subsoils causes great loss of water by percolation.

The writer has made determinations by the chlorine and other methods (see pp. 48–50) of the rate of movement of the underflow beneath the channel of Arkansas River in western Kansas. Six miles below Garden, at a level of 10 feet below the river bed, the velocity was found to be 2½ feet per day. The fall or gradient of the river bed is about 7 feet to the mile. The material below the 10-foot level is coarser than that above, and the velocity in it is undoubtedly higher, although the determined rate must be considered rather high for a gradient of 7 feet to the mile. South of the island, near Garden, the rate was found to be very high, a motion as great as 12 feet per day being determined. The motion at these points seemed to be entirely in the direction of the thalweg, it being impossible to detect any side or cross motion at the particular points where the experiments were made.

Determinations of the rate of underflow in the narrows of the Hondo and San Gabriel rivers, in southern California, by the author's electrical method, gave rates of 3½, 4, 5½, and 7 feet per day. This work is in progress as this paper goes to press.

Gilbert reports that the underflow sands of the Arkansas River Valley in eastern Colorado have a breadth approximately as great as the bottom lands of the river, and range in depth from 5 to 20 and 30 feet.[a] The slope of the water table is from 7 to 15 feet to the mile. The sands are exceedingly variable in texture. One of the coarser of two samples gave a porosity of 29 per cent. The effective size of the grains is not given by Gilbert, but he states that a saturated sample, if freely drained, would part with about one-third of its water in several days. These data, however, are not sufficient to estimate the effective size of grain very closely, but the writer believes that they indicate that the effective size was between 0.05 and 0.1 mm. If the former, the magnitude of the underflow in the river valley, if the sand be assumed to be 20 feet thick and 50 miles wide, with a slope of 10 feet to the mile, is barely 10 cubic feet per minute. If the effective size be assumed to be 0.1 mm., the underflow would be about 36 cubic feet per minute. A sand as coarse as 1 mm. would, under the same conditions, furnish an underflow of 3,600 cubic feet per minute.

RETURN WATERS FROM IRRIGATION.

Some remarkable instances of changes from the condition of diminishing rivers of arid valleys to the condition of growing rivers of humid valleys have been noted in various parts of the West, these being the results of the irrigation of considerable portions of river lands. Data relating to these changes have been given in various

[a] The underground waters of the Arkansas Valley, by G. K. Gilbert: Seventeenth Ann. Rept. U. S. Geol. Survey, Pt. II, 1896, p. 557.

annual reports of the United States Geological Survey, in connection with the results of river measurements, notably on the Gila, Boise,

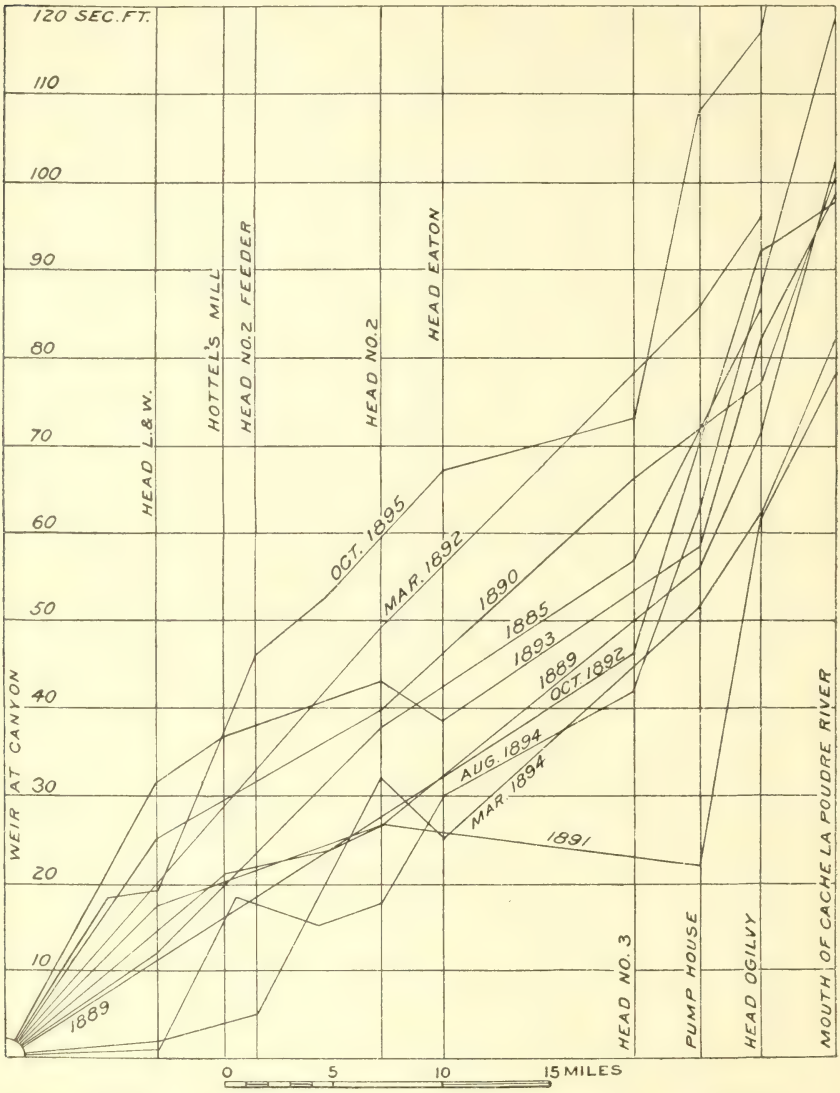


FIG. 16.—Diagram showing growth of Cache la Poudre River. The horizontal distances or abscissæ give the distances in miles from the first weir at the canyon to the point of measurement. The vertical distances or ordinates represent the amount of return waters in cubic feet per second. The distances were measured not along the curves of the river but on the map, taking generally a straight course across the bottoms, because it was thought that the amount of inflow will not be increased by the curves of the river, but, instead, will depend upon the straight course of the stream, other things being equal. It is evident that there is a general agreement between the various lines, notwithstanding certain irregularities, such as the small inflow in the first section in March and August, 1894, and actual losses recorded in the fifth or adjacent sections in 1891, 1893, and 1894.

Platte, and other rivers. One of the most complete series of measurements is that made by Prof. L. G. Carpenter in the valley of Cache

la Poudre River, a tributary of South Platte River, Colorado. As the lands of the valley were gradually brought under cultivation one of the effects first noticed was the gradual saturation of the subsoil and the rise of the water table, a phenomenon very common in all irrigated countries, and usually evidenced by a decided rising of the waters in the wells. In many places in the Cache la Poudre Valley the rise in the water table was from 20 to 40 feet. This addition to the water table and increase in the pressure gradient brought about a gradual seepage toward the river and even the creation of flowing springs and marshy areas. The river was changed from a diminishing stream to an increasing one, so that waters used for irrigation upstream returned as seepage waters to the river and were again withdrawn for irrigation farther downstream, until the same water was used several times. A summary of the measurements of this river down to 1896 is presented graphically in fig. 16.

TABLE VI.

Return waters of Cache la Poudre River, Colorado, from measurements made in 1895.[a]

[There are no tributaries between stations, and all measurements were made in October, when water in stream is as low as it usually gets.]

Station.	Water in river.	Drawn out by canals.	Water in river, plus amount diverted.	Ground-water inflow between stations.	Total ground-water inflow.
	Cu.ft.per sec.	*Cu.ft.per sec.*	*Cu.ft.per sec.*	*Cu.ft.per sec.*	*Cu.ft.per sec.*
No. 1	127.605				
		5.498			
No. 2	133.973		139.471	11.862	11.862
		9.485			
No. 3	149.985		159.470	25.497	37.359
		7.453			
No. 4	161.863		169.316	19.331	56.690
		38.955			
No. 5	153.117		192.072	30.209	86.899

The following are Professor Carpenter's conclusions:[b]

(1) There is a real increase in the volume of the streams as they pass through the irrigated sections.

(2) There is no such increase in the streams as they pass through the unirrigated sections. On the contrary, there is an actual loss, even when the drainage of a large area enters.

(3) The increase is more as the irrigated area is greater.

(4) The increase is approximately proportional to the irrigated area, and it seems probable that with more intimate knowledge of the amount of water applied and the features of the drainage the proportions would be found to be close.

(5) The amount of the increase depends very slightly, if at all, upon the rainfall, and so far as it does it is influenced principally by the rainfall on the irrigated lands. Only where the lands are already saturated is the rainfall sufficient to cause seepage.

(6) There is no perceptible underflow from the side channels even where they drain several thousand square miles.

[a] From Engineering Record, Vol. XIV, p. 48.

[b] Tenth Biennial Report State Engineer of Colorado, 1901, p. 210.

(7) The inflow is practically the same throughout the year. It is more in summer, less in winter, principally because of the effect of the temperature of the soil.

(8) The passage of the seepage water through the soil is very slow, so that it may take years for the seepage from the outlying lands to reach the river.

(9) The amount of seepage is slowly but constantly increasing.

(10) It may be expected to increase for some years to come.

(11) An increased amount of land may be brought under cultivation with time, more especially on the lower portions of the streams.

(12) The seepage being nearly constant throughout the year, while the needs are greatest in summer, the use of storage will best utilize the water from inflow.

* * * * * * *

(15) On the Poudre River about 30 per cent of the water applied in irrigation returned to the river.

(16) The use of water on the upper portions of a stream, when water is not immediately needed by prior appropriations, will increase the flow of the stream late in summer and prevent such low stages as it would have without this resulting action.

(17) The seepage water is already an important factor in the water supply for the agriculture of the State. The capital value of the water thus received in the valley of the Cache la Poudre alone is not less than $300,000, and perhaps $500,000, and for the Platte is from $2,000,000 to $3,000,000. It is large for the other streams, but of unknown amount.

(18) An actual loss is incurred in carrying a stream like the Platte through sandy beds.

(19) Ultimately the returns from seepage will make the lower portions of such valleys as the Platte more certain of water and probably enable a larger acreage to be grown.

EFFECT OF TILE DRAINAGE, ETC.

The effect of the return waters from irrigation in increasing the dry-months flow of a stream and making the available supply of water more constant finds its exact counterpart in the effect of the deforesting and cultivation of the land upon the perennial flow of rivers. The changed condition of the streams and the influence of the light flow in the dry months upon the smaller water powers which have usually followed the settlement of the country are too well known to need special comment. Another striking example of the same kind is observed in river valleys in which large portions of the marshes and lowlands have been reclaimed by tile drainage. The tiling of the land permits the percolating waters from the rains to find almost immediate passage into the streams, while under natural conditions the return seepage would require weeks or months to reach the rivers. Part of the falling off in the reliability of the water power at Aurora, Ill., and other points on Fox River must be attributed to the reclamation of thousands of acres of lowlands in the upper part of its valley.

CHLORINE METHOD OF DETERMINING THE RATE OF THE UNDERFLOW.

Continental engineers formerly attempted to determine the rate of movement of ground water by experimental pumping from a number of test wells, deriving the velocity of flow from computations based

upon these data. A chemical method of tracing the moving ground water was occasionally used with success. The earliest instance of this nature was probably the successful attempt to trace the origin of an underground vein of water encountered in building a tunnel in Switzerland by charging the ground water with common salt.

A. Thiem introduced a similar method in his investigations of ground-water movements near Leipzig. His method is as follows: In line with the probable direction of motion he digs two test wells at a known distance apart. In the upper well he places a substance which is readily dissolved by water and can easily be tested by chemical analysis. He then takes samples of the water at suitable intervals from the lower well, from the analysis of which he is able to draw conclusions as to the rate of flow. The dissolved chemical penetrates

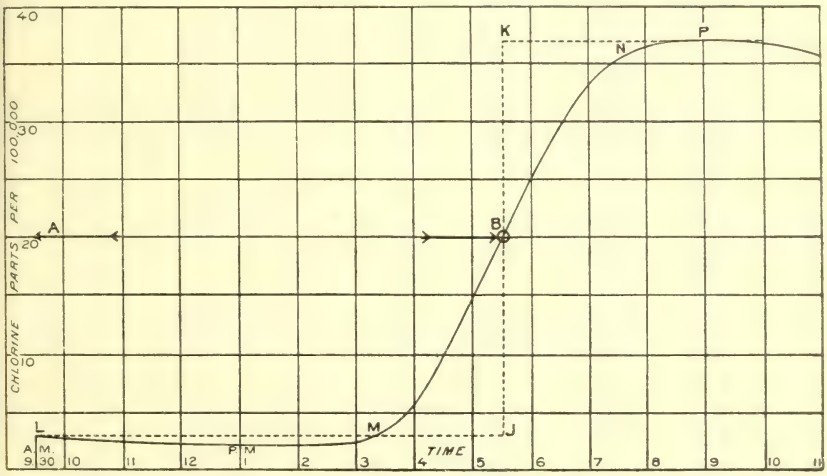


FIG. 17.—Curve obtained in determining the velocity of ground water by the chlorine method. The distance A B represents the time of passage of the ground water between two wells. B is the point of inflection of the curve. The dotted line L J K P is the form that the curve would take if there were no diffusion of the salt. The rounded parts M and N are due to diffusion. German hydrographers have incorrectly used the maximum point P for the determination of the velocity instead of the point of inflection B.

in all directions radially from the place of its introduction in the water-bearing strata, with greater or less velocity, according to the permeability of the ground, and in concentrically decreasing strength of solution. Since the entire body of water during the distribution of the solution moves at the same time in the direction of the second well, the movement of the chemical is greater in half of the circuit of the charged water than in the other half, according as the diffusion takes place with or against the natural current of the ground water. The shorter the distance between the test wells the greater the degree of concentration. The velocity of the ground-water stream is determined by plotting the results of simultaneous analyses from both wells. (See fig. 17.)

Thiem used common salt in his experiments, because it is rapidly

soluble and is easily determined chemically; and it has the further advantages of neither poisoning nor discoloring the ground water. He used this method in the new water-supply systems at Greiswald and Stralsund with good results.[a]

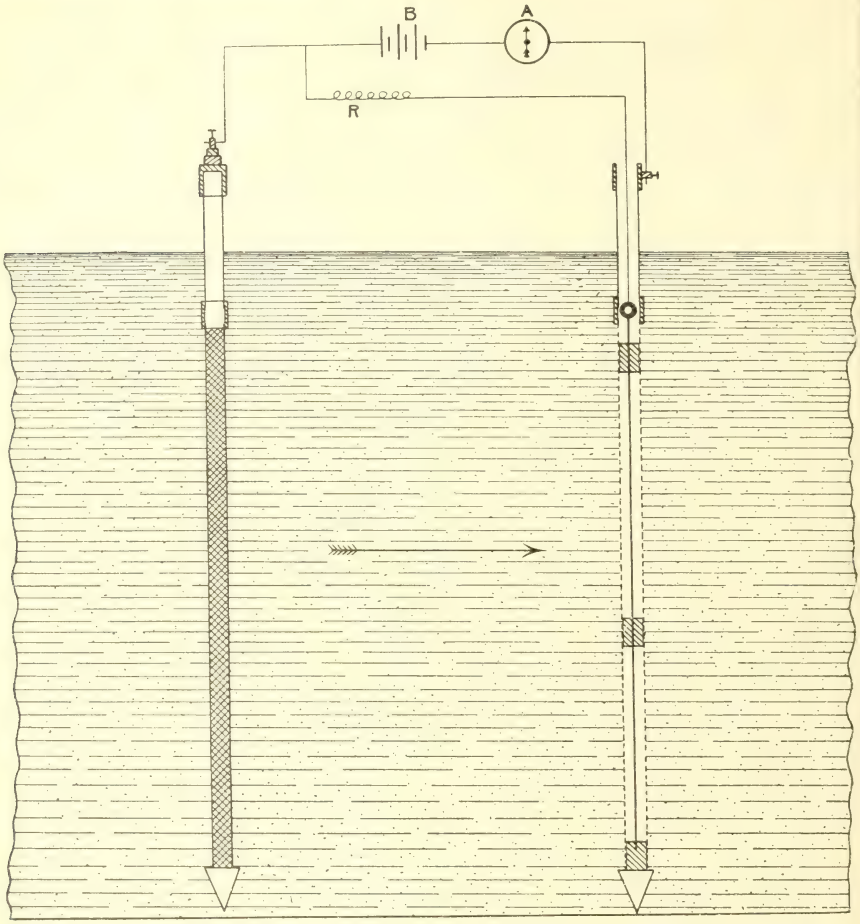


FIG. 18.—Diagram illustrating the author's electrical method of determining the horizontal velocity of ground water. The ground water is supposed to be moving in the direction of the arrow. The upstream drive well is charged with an electrolyte. The gradual motion of the ground water toward the lower well and its final arrival at that well are registered by the ammeter A. B is the battery and R a suitable resistance.

THE AUTHOR'S METHOD OF DETERMINING THE RATE OF THE UNDERFLOW.

A more rapid and less laborious method of surveying underground currents of ground waters than the chlorine method becomes almost imperative when extensive surveys are undertaken. Since July, 1901, the writer has given much attention to the development of a new

[a] Verfahren für Messung natürlicher Grundwassergeschwindigkeiten, by A. Thiem: Polyt. Notizblatt, Vol. XLII, 1887, p. 229.

method intended to be especially applicable to the survey of the underflow streams of the Plains. Acting under the authority of the chief hydrographer of the United States Geological Survey, he made preliminary field tests along the valley of Arkansas River in western Kansas during the month of August, 1901, and has continued the work in the laboratory and field since that time. The experiments seem to leave little to be desired either in the certainty of the results or in the rapidity with which work can be prosecuted. The method is an electrical one. A double row of 1¼-inch drive wells is sunk across the channel of the river whose underflow is to be tested. The upstream wells are then charged with a strong electrolyte, which dissolves and passes downstream with the moving water. (See fig 18.)

The passage of the electrolyte toward the lower well is shown by the gradual movement of the needle of an electrical instrument, and

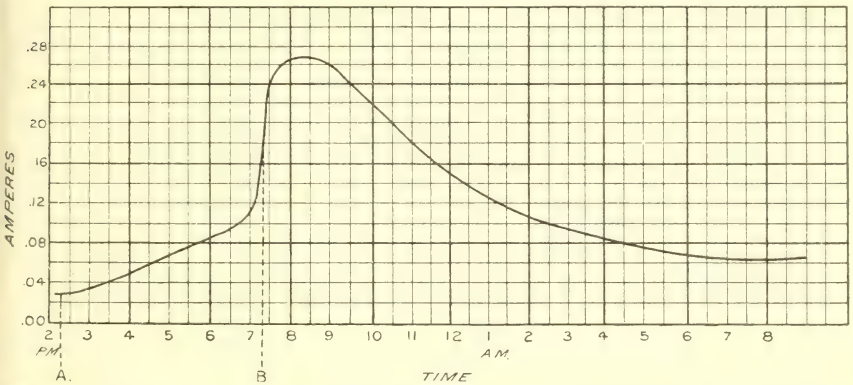


FIG. 19.—Curve obtained by the author's electrical method of determining the velocity of ground water. The distance A B represents the time of passage of the ground water from the upper to the lower well. The sudden deflection at B shows the final arrival of the electrolyte at the lower well. The point B should be taken at the point of inflection of the curve and not at the highest or maximum point. If the point of inflection be taken the effect of the diffusion of the electrolyte will be nullified.

the final arrival at the well is shown by a sudden and strong deflection of the needle. (See fig. 19.) It is exceedingly interesting to watch the gradual movement of the water in this indirect way. In an hour or two a very good indication of the rate can be obtained by noting the slope of the current curve obtained. If several of a row of wells are being used simultaneously, the main stem of the underground current will show itself by the rapidly rising electrical currents corresponding to certain of the wells. Thus not only are the tedious chemical analyses of the chlorine method obviated, but the actual movement of the water is traced from the beginning of the experiment, which is impossible in the older methods.

Numerous electrolytes have been tried, both in the laboratory and in the field. It is obvious that the electrolyte must possess the following properties: (1) It must be readily soluble in water; (2) it must

be chemically inactive to the dissolved matter in natural waters or to the material of the pervious medium; (3) it must possess a low coefficient of diffusion; (4) it must possess a high conductivity; and (5) its cost must be low. Of the numerous salts tried up to the present time ammonium chloride has given the best results. With this salt a current of sufficient intensity to throw the needle of a recording ammeter can be obtained by the use of a few dry cells.

The electric circuit to the wells can be made in various ways. A brass rod insulated from the well tube and lowered into the downstream well by means of a rubber-covered wire may serve as one electrode, the casing of the same well constituting the other electrode. In this case the indication of the movement of the ground water will not be noted until the electrolyte has reached the lower well, where its presence will be shown by a sharp rise in the current curve. Instead of this the two wells themselves may be used as electrodes, in which case the gradual passage of the electrolyte downstream can be observed from the beginning, but the final indications of its arrival at the lower well are less pronounced. The best method is a combination of these two: Run the wire from the casing of the lower well to one pole of the battery, with the ammeter in circuit, and connect the other pole of the battery both to the internal electrode of the lower well and to the casing of the upper well. In this case the gradual movement of the ground water from one well to the other is shown on the ammeter chart, and an abrupt indication of the arrival of the electrolyte at the lower well is also recorded.

The drive wells may be made of perforated sections from 4 to 8 feet long, so that a well will offer free passage to the water throughout its entire length. The internal electrode may be made in several insulated links with separate external wires, so that varying velocities at different depths can readily be determined.

While making tests in the underflow of Hondo River, California, the author was able to determine the different velocities in three different strata of gravel penetrated by the wells by a single setting of the wells. The curve developed three well-marked points of inflection, corresponding to the velocities in the several strata, and the brass screens on the well point and well-point extension were blackened by the electrolyte at depths corresponding to the three strata.

Underflow measurements were made by the author on Mohave River at the site of the proposed dam near Victorville, Cal. At this point the river passes through a narrow gorge, barely 120 feet wide at the river surface. Here the greatest depth to bed rock is 47 feet, and the material is a very coarse granite sand or fine gravel. A double row of test wells across the narrows, with extra downstream wells for the determination of the direction of flow, gave velocities at various points of 6, 8, 20, 35, 48, and 64 feet per day. Notwithstanding these high rates the total volume of underflow is quite small on account of

the limited cross section (4,160 square feet). For a cross section at the dam site see Eighteenth Ann. Rept. U. S. Geol. Survey, Part IV, page 709. Estimating a porosity of 33 per cent and an average velocity of 50 feet per day gives a total underflow of 0.8 second-foot, or 520,000 gallons per twenty-four hours.

The velocities at this point were so high that the electrolyte passed between wells only 18 inches apart without touching them, and a small quantity of caustic potash had to be added to spread the electrolyte into a broad stream.

CONCLUSIONS.

The important facts concerning the underflow of rivers are brought together in the following summary:

(1) In the mountainous portions of streams, where the river slope is great and the material deposited in the river channel is coarse, the underflow in the direction of the thalweg may be relatively very large.

(2) The seepage in the steeper slopes and terraces of a river valley is primarily in a direction toward the thalweg and not along it.

(3) The underflow in the alluvium beneath the surface of the bottom lands of the valley is greater in the direction toward the channel than in the direction of the thalweg, except (*a*) where the water table has a greater slope downstream than toward the channel, and (*b*) where the fine silt of the river channel covers deeper deposits of coarser material, rendering seepage into the channel difficult and underground passage downstream easy.

(4) The velocity of the underflow is very small and the total amount is commonly greatly exaggerated.

(5) The rate of the underflow is especially small in the beds of overloaded, silt-depositing streams, although the storage capacity in such cases may be correspondingly great.

CHAPTER III.

DEEP ZONES OF FLOW.

The sedimentary rocks usually occur in alternating layers of sandstone, shale, and limestone, or in alternating successions of sandstone and shale. These classes of rocks represent the various kinds of deposits which are laid down on the floor of the sea. Originally the sandstone was sand, deposited near shore in the more rapidly moving water. The shale was mud, deposited in the belt of sluggish currents in shallow water. The limestone was limy ooze, the remains of lime-secreting organisms upon the deeper and quiescent floor of the sea. Sand and mud are therefore called mechanical sediments and the calcareous ooze is called an organic sediment.

Water is, then, not only the transporter of the material worn from the shore and the surface of the land, but it is also the sorter of that material. The gradual change in the shore line by erosion and by alternating elevation and subsidence of the land has caused rocks of these various classes to be deposited above one another in a more or less regular threefold succession, shale above sandstone and limestone above shale. The various strata are usually not arranged, therefore, like the leaves of a book, in perfectly horizontal and coextensive layers, but the arrangement is better likened to the overlapping of the shingles on the roof of a house, sediments of one class being imbricated with those of the other classes. The higher ends of the strata correspond to the deposits laid down near the shore, unless earth movements have inverted the direction of the original dip.

The common alternation of sandstone, shale, and limestone found in the sedimentary rocks is a fact of the greatest importance in the consideration of the motion of underground waters. The sandstones are in general the most pervious of all water-bearing rocks, and the shales are usually the most impervious. Generally limestone is to be classed as an impervious rock, although frequently it is a water-bearing rock of great importance.

Important classes of pervious limestones are the following: (1) Chalk and partially consolidated shelly limestone, such as coquina, etc.; (2) limestone that has at one time been exposed in the belt of

weathering (The solvent action of surface waters upon limestones and the readiness with which they are rendered cavernous and prolific bearers of water are too well known to require special comment.); and (3) deeply buried limestone in which a portion of the carbonate of lime has been replaced by dolomite or carbonate of magnesium. The dolomite being less bulky than the chemical equivalent of calcium carbonate, the substitution may render the limestone sufficiently porous to become an important water-bearing rock. A well-known example is the Trenton limestone in Ohio, which bears enormous quantities of water, oil, and natural gas in its upper dolomite layers.[a] The substitution of basal magnesium for calcium may in itself account for a porosity of from 10 to 12½ per cent.

The sandstones are not only confined by impervious material above them and often below them, but their exposures above the surface of the land are normally covered with a very pervious, coarse, sandy soil which readily imbibes the rainfall. Thus all of the elements are present for the storage and circulation of underground waters in the zones of the sedimentary rocks far below the surface zone of flow.

DISTINGUISHING FEATURES.

The pervious and water-bearing sandstones and limestones beneath the surface zone of flow constitute what we have called the deeper zones of flow. There may be several of these deeper zones, or they may be absent altogether. When present, they are distinguished from the surface zone of flow by the following characteristics:

(1) The surface zone of flow has a free, unconfined upper boundary (the water table) and an impervious lower boundary. The deep zone of flow has an impervious upper boundary as well as an impervious lower boundary.

(2) The unit of the upper zone of flow is the drainage area or river valley. The unit of the deep zone of flow is regional and geologic and not dependent upon surface contours. However, it must not be forgotten that the deeper geologic structure is frequently the principal determining factor controlling the surface drainage, so that the deep zones of flow do not commonly run counter to the direction of the surface flow.

(3) The surface zone of flow is dependent upon the local rainfall of the immediate region. The deeper zones of flow receive their waters from distant areas.

(4) The surface zone of flow is in part above the level of surface-drainage channels, while the deeper zones are entirely below the local drainage level.

---

[a] For more complete discussion see Rock waters of Ohio, by Edward Orton. Nineteenth Ann. Rept. U. S. Geol. Survey, Pt. IV, 1899, p. 640.

(5) There is commonly a difference in the chemical composition of the waters from the two zones. It is difficult in our present state of knowledge to make valuable generalizations. The waters of the surface zones are usually less mineralized than those of deep strata, but in arid regions this general rule is frequently reversed. The carbonates are the predominant salts of the surface waters. The deeper waters are usually characterized by rather high amounts of dissolved chlorides. Waters of the surface zone contain dissolved oxygen gas, which is almost entirely absent from the deep waters.

Some of these distinctions (1, 2, and 4 above) are illustrated by the accompanying ideal cross section through South Dakota (fig. 20). This section is along a line from Sioux Falls to Chamberlain and thence along the thalweg of White River to the Black Hills. The diagram is based upon similar drawings published by Darton, Todd, and others, but without attempt to show with absolute accuracy the geologic details. The deep zone of flow is approximately from west to east, through the porous strata marked Dakota sandstone, the water entering at an elevation of more than 3,000 feet, at B. The impervious upper layer is the Benton shale or clay. This cross section presents considerable variety in the surface zones of flow. Between C and D the upper zone of ground water drains from east and west into Cheyenne River, which here flows north. From D to E the surface ground waters drain from north and south into White River. From E to F is the valley of the Missouri. East of this river the surface of the land is covered with glacial drift, represented by the light surface shading in the diagram. At G is James River; at H and I are the forks of Vermilion River, and at J is Big Sioux River. These streams flow to the south, so that the surface ground-water seepage is substantially east and west.

PERCOLATION INTO DEEP ZONES.

The rainfall finds its way into the deeper zones of flow in various ways, either directly by percolation into the exposed ends of the pervious strata, or indirectly by the seepage from streams and rivers which have cut their valleys through the outcrops. The water must leave the deep zone at a lower level than that at which it enters, and hence the outlets for the water must be sought in the lower outcrops of the rock, where, perhaps, a river has eroded a channel through it, or where the impervious cover is locally absent. There is also always the possibility of the escape of water through joints and faults, and even by seepage through the covering strata, for imperviousness as applied to rocks is merely a relative term. The covering layer of shale or hard rock has an enormously greater area than the vertical transmitting section of the pervious rock, so what the covering rock lacks in permeability it can make up in area.

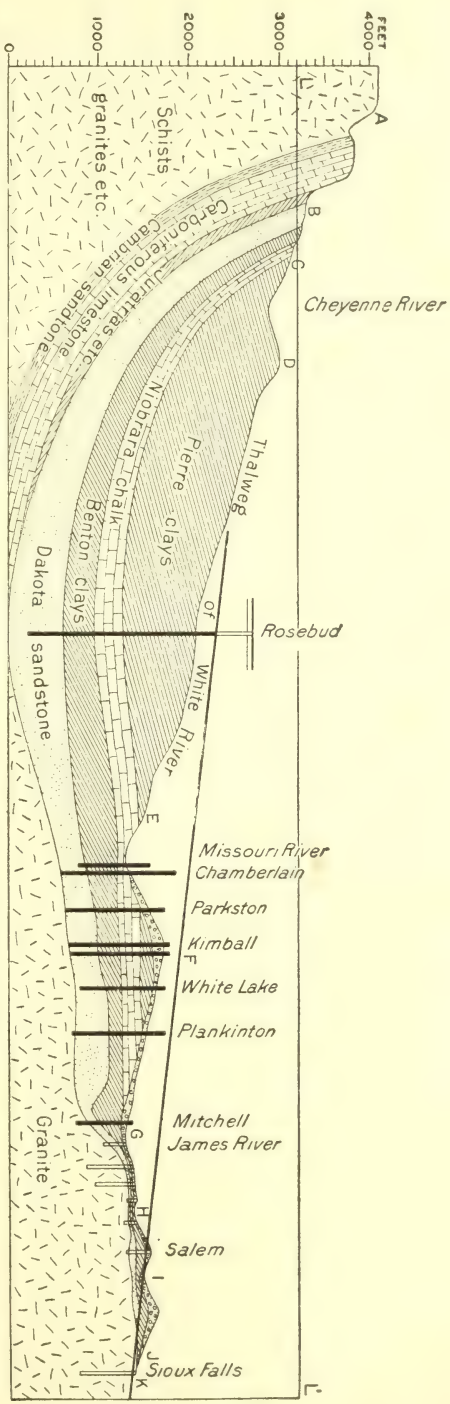


FIG. 20.—Cross section through South Dakota artesian basin, based upon published data of Darton, Todd, and others. The section is along a line through Sioux Falls and Chamberlain and thence along the thalweg of White River. All of the wells shown are within a few miles of this line, excepting the Rosebud well, which is 25 or 30 miles from the line and on much higher land. The base of altitudes is the sea level. The height to which the water would rise in a closed tube at the various wells is shown by the heavy black lines. In studying the drawing one should remember that it has been necessary to use a scale which greatly exaggerates vertical, in comparison with horizontal, distances.

The ratio of the cross section of the Potsdam sandstone to the area of the covering strata is certainly no less than 1: 3,000, for the average thickness of the Potsdam is about 700 feet, while the formation is known to exist as a water-bearing rock for at least 400 miles south of the catchment area. The average thickness of the Dakota sandstone is approximately 200 feet, while the distance from the catchment area in the Black Hills to the eastern outcrop at Yankton is about 350 miles, so that the ratio of the area of the transmitting cross section of the porous strata to the area of the covering strata is about 1: 9,000. Thus if, on the average, the covering material had in the one case only $\frac{1}{3000}$ and in the other only $\frac{1}{9000}$ of the transmission capacity of the water-bearing stone, there would still be as great opportunity for the upward escape of the water as for its onward movement. This upward seepage would cause motion of the water in the porous strata, so that motion is possible even if there be no actual outcrop of the transmitting rock.

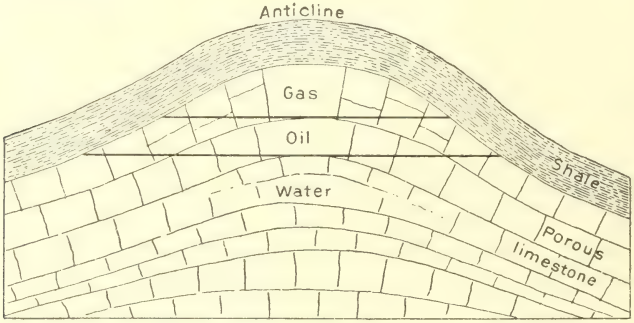


FIG. 21.—Diagram illustrating how gas and oil have been retained beneath anticlines of shale during protracted geologic intervals, thus proving the substantial imperviousness of the covering.

Local upward seepage may explain, perhaps, some of the anomalous variations in pressure of underground water in artesian basins. It is certain, however, that upward leakage is entirely absent over large areas. In the Ohio oil regions, for example, all of the oil and natural gas, not being continually supplied to the rock as water is, would have escaped ages ago if we suppose the most minute permeability to the overlying strata of shale. The gas and oil are held under the anticline of shale as shown in fig. 21, just as air may be held under a basin inverted in a tub of water. It would seem equally reasonable to suppose that the briny water which underlies the petroleum has occupied its present position during the same geologic interval as that in which the petroleum has been impounded. While this may be true in special instances, it is far from being the necessary conclusion, for the water on which the oil floats is a continuous body, and is free to flow toward an outlet in a distant portion of the formation, while the oil and gas, confined by their low density to a particular anticline, can not escape so long as their own covering holds, even though a neighboring anticline be pervious and leaky.

The following water-bearing formations of wide extent and of high economic importance may be specially mentioned as good illustrations of deep zones of flow:

(1) The Dakota formation, commonly referred to as the Dakota sandstone, outcropping in the Black Hills and in the foothills of the Rocky Mountains, and underlying the Dakotas, Nebraska, and Kansas, and of unknown extent northward.

(2) The Potsdam sandstone, outcropping in a V-shaped area in central Wisconsin, dipping southward under Illinois, Iowa, Indiana, and Ohio at great depths, and outcropping again in the great uplift which has formed the Rocky Mountains.

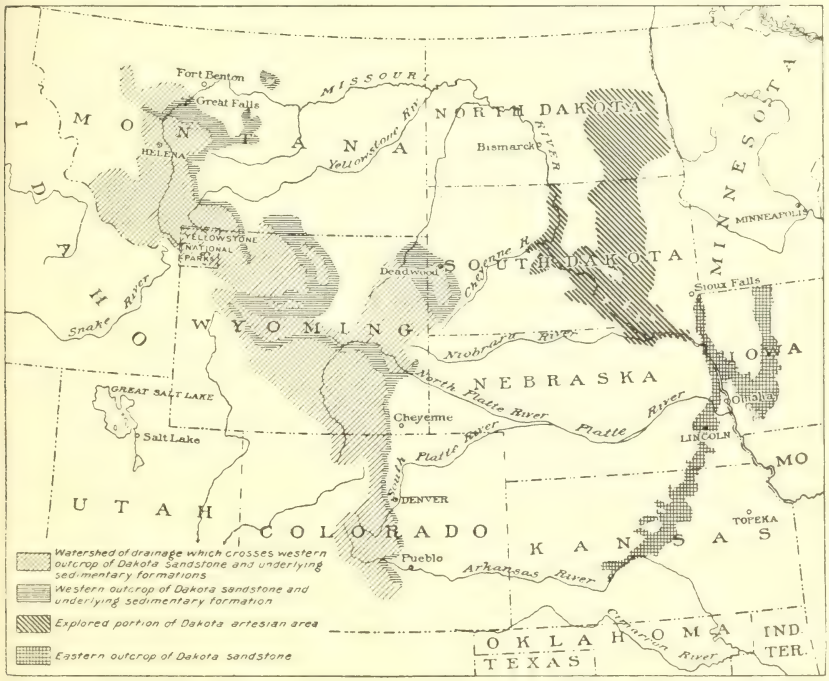


FIG. 22.—Darton's map of catchment area of the Dakota and the Dakota artesian basin.

(3) The Atlantic Coastal Plain deposits, extending along the eastern margin of the Alantic slope from Long Island to Texas, and about 100 miles in width. These consist of a succession of unconsolidated deposits consisting mainly of sands, clays, and marls, instead of sandstone, shale, and limestone, which lie on the east-sloping floor of the crystalline rocks. The western edge has an altitude of from 300 to 400 feet above the sea.

DAKOTA FORMATION.

Darton's map (fig. 22) of the outcrop of this formation in the Black Hills and in the foothills of the Rockies shows the source of the supply of water to the formation so far as known. The map shows not only the surface outcrop, but also the drainage area that is tributary

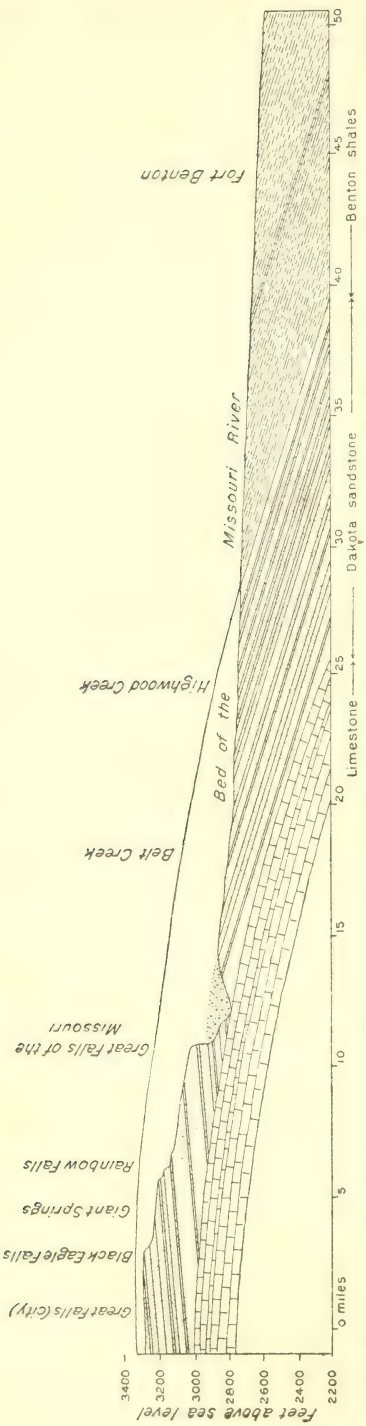


FIG. 23.—Section along Missouri River near Great Falls, Mont. It here appears that Missouri River flows across the Dakota formation, in which it loses a large amount of water.

to it. Darton gives the approximate area of these outcrops of permeable beds as follows: Black Hills, 2,400 square miles; Bighorn Mountains, 7,000 square miles; Rocky Mountain foothills in Montana, more than 3,000 square miles; Rocky Mountain foothills in Wyoming, about 1,500 square miles; total, 13,900 square miles.

The Dakota sandstone in the Black Hills receives water as follows:

(1) Of the rain which falls on the Dakota sandstone probably one-fourth is directly absorbed by this rock.

(2) All the drainage of the Hills crosses the Dakota sandstone, which therefore receives a second accession.

(3) A probable third accession is from the Carboniferous group which underlies the Dakota sandstone. Many streams of the Hills either sink or lose considerable water in the lower beds of the Carboniferous. Inasmuch as this group thins out and is apparently absent in the eastern part of the basin, it is probable that a portion of this water is passed along to the Dakota sandstone.

Missouri River flows over the outcrop of the Dakota sandstone in passing from Great Falls to Fort Benton, Mont., as can be seen from consulting Darton's map (fig. 22) and the accompanying section (fig. 23). In this part of its course the river is believed to lose a considerable volume of water.

The elevation of the outcrop of the Dakota sandstone in the Black Hills is from 3,100 to 3,800 feet above sea level. The outcrop far-

ther west, in the foothills, reaches an elevation much higher, as can be seen by consulting fig. 22. The sandstone comes to the surface again in southeastern Dakota, near Yankton, and along Missouri and Big Sioux rivers, at an elevation of about 1,200 feet. In this area there is evidence of leakage from the sandstone, probably greatest in the neighborhood of Yankton. At Chamberlain, Running Water,

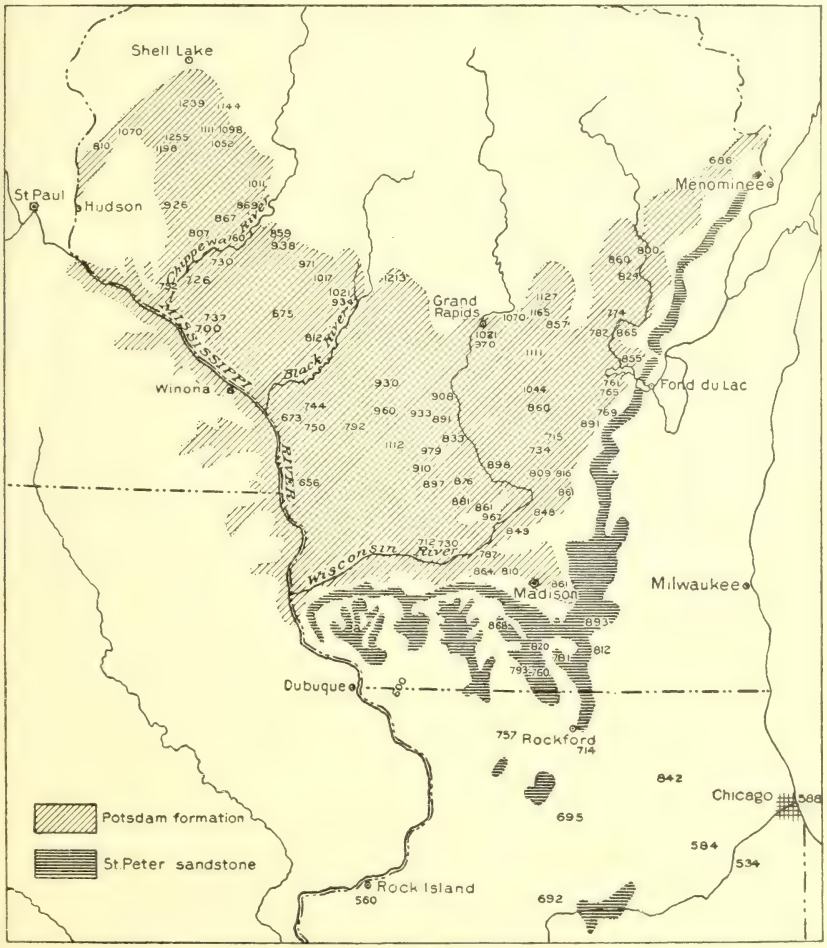


FIG. 24.—Wisconsin outcrop of Potsdam and St. Peter sandstones. Figures indicate height, in feet, above mean sea level.

and Randall, springs are seen rising from the bed of Missouri River. Through extensive areas in Dakota this subterranean water is under enormous pressure and constitutes one of the most remarkable artesian areas in the world. More will be said of this area later.

POTSDAM FORMATION.

The Wisconsin outcrop of this water-bearing series is shown in fig. 24. The altitude of the V-shaped outcrop is in the neighborhood

of from 900 to 1,000 feet above sea level. The soil above the outcrop is sandy and porous over extensive areas, making the catchment area especially favorable for the imbibition of water. The area of the outcrop is nearly 12,000 square miles, and the thickness of the formation reaches a maximum of nearly 1,000 feet. The strata of the series are mostly porous sandstones, with occasional layers of shale and some beds of limestone. The Potsdam is overlain by the Lower Magnesian limestone, varying in thickness from 65 to 250 feet. Overlying the Lower Magnesian is another water-bearing sandstone of great importance, known as the St. Peter. It varies in thickness from 212 feet to a fraction of a foot, the average being probably between 80 and 100 feet. The rock is of an exceedingly friable character, being, as a rule, hardly compact enough to permit handling. Overlying the St. Peter is the Trenton limestone. The Potsdam and its overlying strata dip gently away from the V-shaped outcrop.

The water-bearing sandstones of these formations supply artesian water of exceptional purity to large areas in southern Wisconsin, northern Illinois, and northeastern Iowa. The head of the flowing wells is not high anywhere within the area, and at many places the wells have to be pumped. This artesian basin is remarkable on account of its large areal extent and the excellent quality of the water rather than the large flow of individual wells. The usual yield of carefully constructed wells varies from 50 to 300 gallons a minute.[a]

[a] A tabulation of the data from wells in Illinois will be found on page 810 of the Nineteenth Annual Report of the United States Geological Survey, Part II; see also Vol VI, Iowa Geological Survey.

CHAPTER IV.

RECOVERY OF UNDERGROUND WATER FROM THE SURFACE FLOWS.

It has already been explained that underground water comes to the surface and joins the surface waters by diffused seepage into rivers, lakes, and marshes, and into the bed of the sea. It has also been pointed

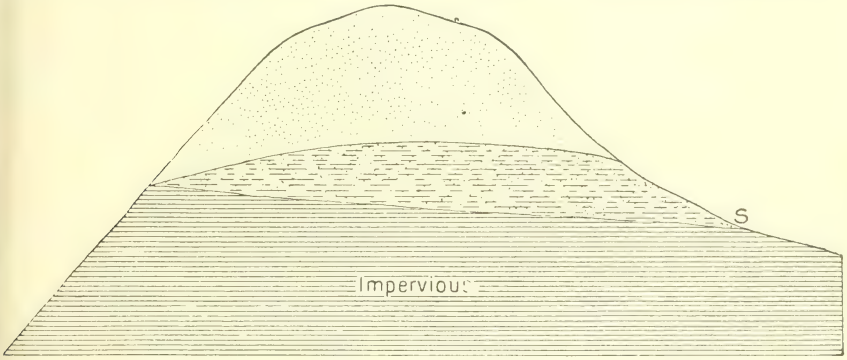


FIG. 25.—Diagram showing the formation of a stratum spring at an outcrop of an inclined impervious stratum, as at S.

out that if the return seepage, owing to unusual geologic conditions, is strongly concentrated in special areas, the returning water constitutes a spring or a natural fountain. A surface spring is usually

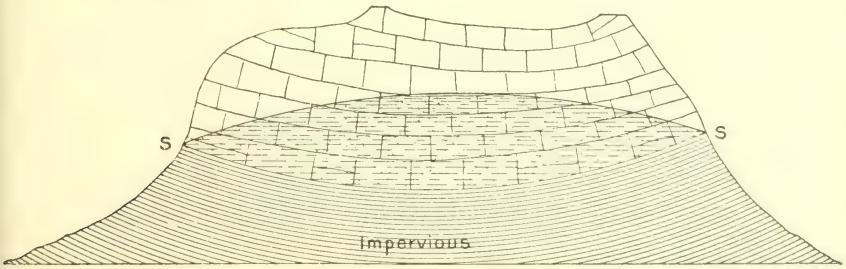


FIG. 26.—Diagram showing the formation (at SS) of overflow springs at the edges of a basin of impervious material.

associated with an outcrop of an impervious stratum. The simplest form is shown at S, fig. 25, which, if we follow the classification of Haas, may be called a stratum spring. A fault in the bed rock may

force the ground water to the surface, forming a so-called fault spring, as at "Spring B," fig. 1, page 13. Other forms are overflow springs, as at SS, fig. 26; chasm springs, as in fig. 27, or valley springs, as at "Spring A," fig. 1, page 13. A stratum spring is shown in Pl. IV, *A*.

COMMON OPEN WELLS.

Besides these natural processes which are constantly returning underground waters to the surface waters, there are several well-known ways of artifically restoring ground waters to the surface. The most common of all methods is, of course, the construction of an open well and the raising of the water to the surface by appropriate mechanical means, as shown in fig. 28. This is so universal a practice that it requires but little discussion. The well is simply excavated to a suitable depth below the water table, so that the ground water of the surface zone of flow is free to flow into the excavation.

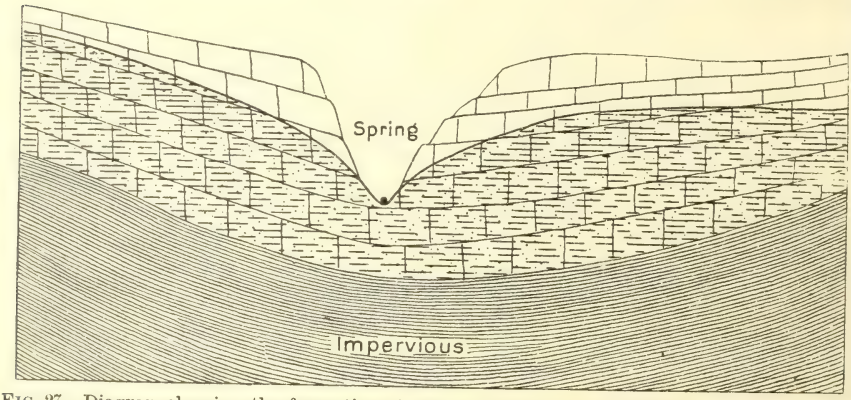


FIG. 27.—Diagram showing the formation of chasm springs in a cut which extends below the natural level of ground waters.

The result of the regular removal of water from the well is the lowering of the water table in its neighborhood, the water table assuming the very regular curve shown in figs. 28, 29, and 31. The form of this surface can be worked out from theoretical considerations, and the results seem to agree substantially with experiment. These figures (29, 30, and 31) are taken from the report of a very carefully conducted series of experiments by J. C. Hoadley, C. E., of Boston, Mass.[a] The investigations are known as the Melrose or Malden experiments, because the first series was carried out in the town of Melrose, near the boundary of Malden, and on the border of the uncultivated tract known as Middlesex Fells.

Fig. 29 shows the varying position of the water table on May 24, 1882, near a 3-inch pipe, during ten hours of continuous pumping at

[a] See Sanitary Engineer, Vol. XI, 1884, pp. 11, 35, 60, 84, and Proc. Soc. Arts, Boston, 1882-83, p. 115.

A. SPRING FORMED AT OUTCROP OF AN IMPERVIOUS FLOOR.

B. ARTESIAN WELL.

a mean and nearly uniform rate of 2,313 gallons an hour. The pumping was from a 1½-inch suction pipe dropped loosely into the well. There had been no pumping from the well for seventy-five hours preceding the experiment. The head required to force the water into the 1½-inch pipe with open end (no holes) and to overcome bends and friction in pipe was 29.5−20.75=8.75 feet. The barometer stood at

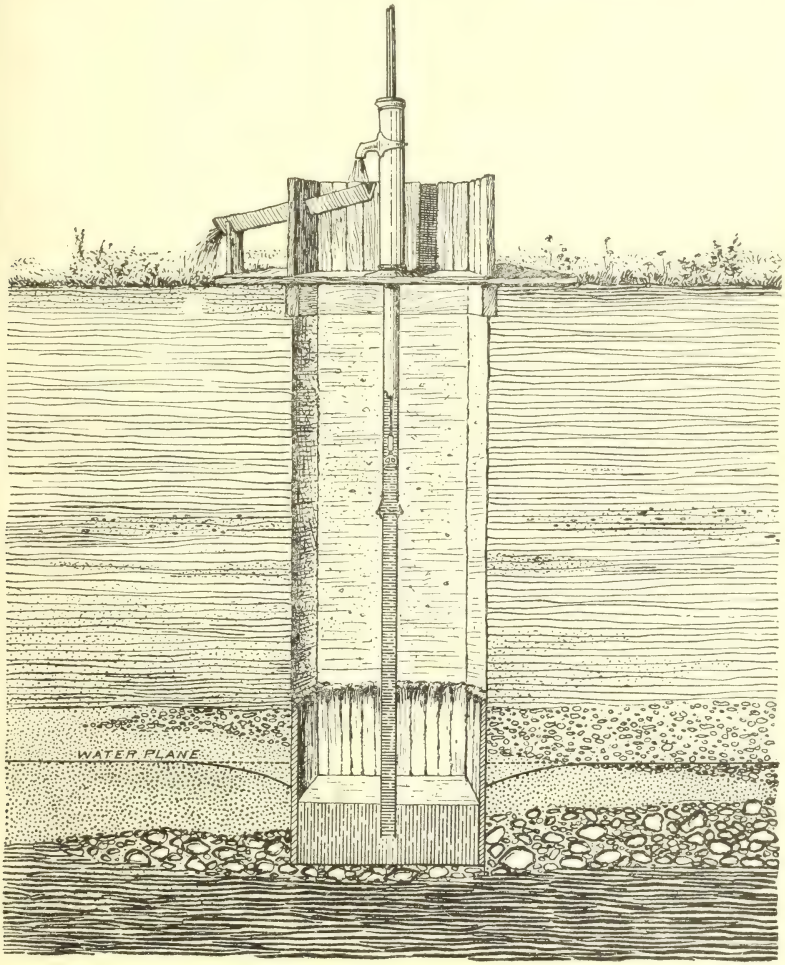


FIG. 28.—Common dug well; shallow in water.

30.015 inches, the thermometer at 67.6° F. The height of partial vacuum in suction pipe, as indicated by vacuum gage, was 20.75 feet above base; height of absolute vacuum, as indicated by vacuum gage above the base line, was 6.75 feet; height of valve seat of steam pump above base, 40.80 feet. Fig. 30 shows the effect of pumping, of stopping the pump, and of rain, upon the height of ground water in one of

the wells. The pumping was at the rate of 2,010 gallons an hour, except for several stops indicated on the diagram.

Fig. 31 illustrates a very excellent apparatus designed by Hoadley for the experimental study of well phenomena in the laboratory. The

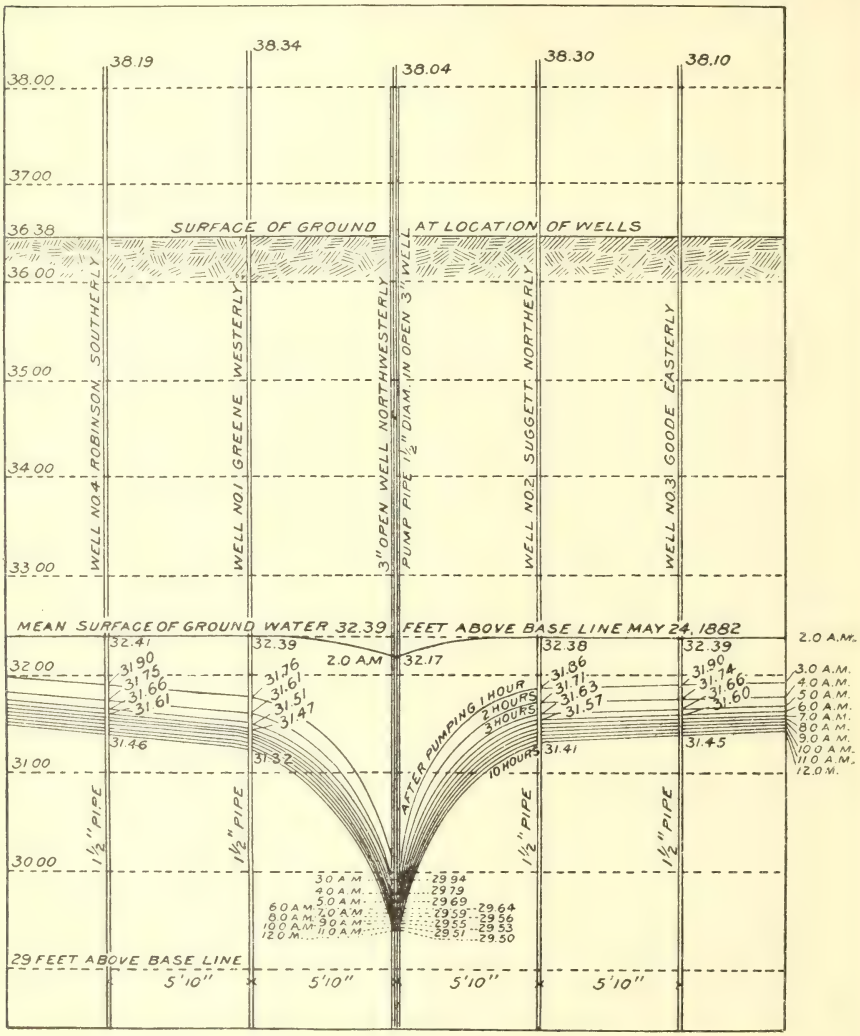


Fig. 29.—Diagram illustrating the changing position of the water table near a 3-inch well during ten consecutive hours of continuous pumping at an average rate of 2,313 gallons an hour. (After Hoadley.)

sand is held within a 48-inch cylindrical curb of wire cloth, so placed in a larger tank as to leave a 1-inch space all round, which can be kept filled with water to supply the sand during experimental pumping from a well at the center of the cylinder. Numerous brass tubes drilled with fine holes occupy positions in the sand at various dis-

tances from the central well and communicate with appropriate gages of glass tubes, from which the position of the ground-water surface in the sand can be determined at any time, as shown in the lower part of fig. 31.

The capacity of surface wells depends upon several factors. Perhaps the most important is the degree of fineness of the material of the water-bearing stratum. The size of the soil grains not only controls the rate at which water can be transmitted to the well, but also determines the proportion of the contained water which the soil will freely part with. The fine-grained soils retain a considerable proportion of the water of saturation as capillary water, even after free means of

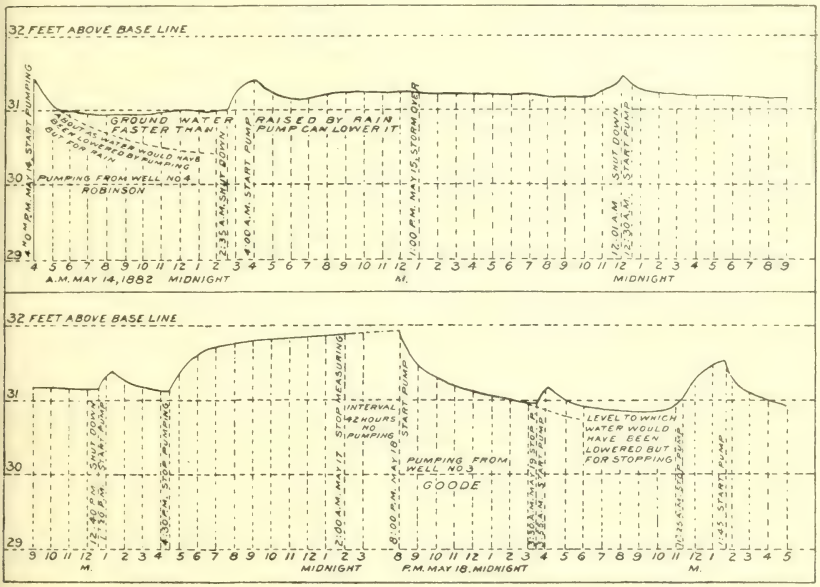


FIG. 30.—Diagram illustrating the varying position of the water table in a well due to pumping for various intervals and modified by rainfall and stops of various duration. (After Hoadley.)

drainage are established, so that fine-grained material will not only deliver water slowly but will furnish only a small total amount. The yield of the well also depends upon the amount that the water table is lowered by the withdrawal of water, or the head under which the flow takes place, and upon the size and shape of the excavation and the character of the walls and casing. Theoretical considerations seem to show that the yield of a well is directly proportional to the transmission constant (k of formula on page 26 of this paper) of the porous material, and nearly proportional to the head, or the distance the water table is lowered. If the well is deep and relatively small in diameter (say from 6 to 12 inches), increasing the diameter seems to

have little effect on the volume, doubling the diameter adding barely 8 or 10 per cent to the theoretical yield; while if the well is shallow and porportionately large in diameter the yield seems to be proportional to the diameter, so that doubling the diameter would double the flow. This dependence of yield upon diameter is only true when the well is being used to nearly its full capacity. When the well is drawn upon for but a small percentage of its full capacity the indications are that doubling the diameter will have a greater effect no the capacity of the well than these figures indicate.[a]

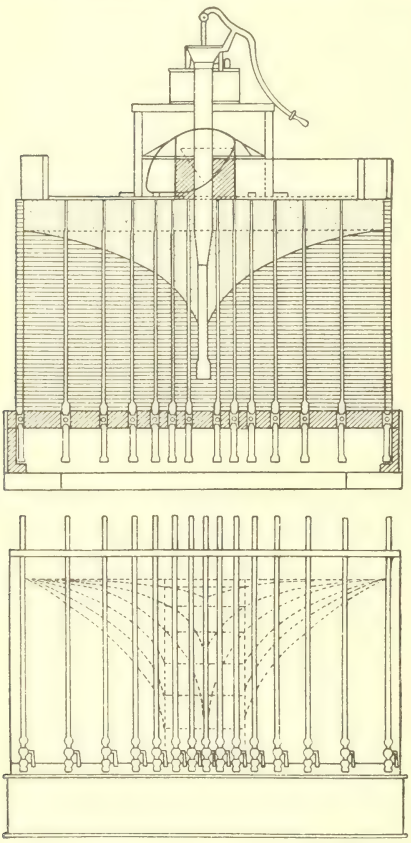


FIG. 31.—Hoadley's laboratory apparatus for the investigation of the phenomena of common open and driven wells.

As already stated, the flow of ground water into a well, if it be not too shallow, varies directly as the distance the surface of the water in the well is lowered by pumping. Thus, if the water in a well is lowered 2 feet below the natural level by pumping from it at the rate of 20 gallons a minute, the same well may be expected to yield approximately 40 gallons a minute if the water is lowered 4 feet below the natural level. For shallow wells the yield will not increase in this direct ratio, but will be considerably less, on account of the decrease in percolating surface, due to the lowering of the water table in the neighborhood of the well. Besides the advantages just mentioned, tubular wells, owing to their greater depth, are much more likely to strike a vein of coarse material, a small stratum of which may be expected to furnish much more water than a considerable depth of fine material. This accounts for the well-known superiority of deep tubular wells over common dug wells. When a large supply of water is required, as for irrigation or for village supply, it is a common practice to sink several tubular wells in the bottom of a large dug well (see fig. 32). In this way not only is a large supply obtained, but the large well acts as

[a] See the author's theoretical investigation of the motion of ground waters. Nineteenth Ann. Rept. U. S. Geol. Survey, Pt. II, 1899, pp. 358, 362, 364.

a storage reservoir, equalizing the load upon the pumps and permitting temporary overdrafts of the capacity of the wells. Some careful meaurements of the rate of rise of the water surface in a well after pumping has ceased have been made by Mr. Willard D. Johnson. Data from the city well at Garden, Kans., as obtained by him, are shown in figs. 33 and 34. The curve in fig. 34 agrees very closely with

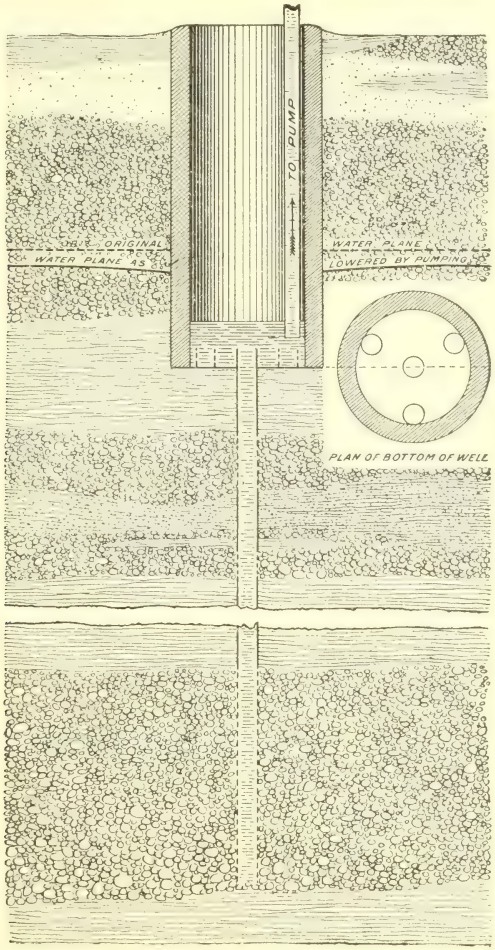


FIG. 32.—Combination dug and tubular well.

estimates based on theoretical considerations, which indicate that if at the end of a certain period of time (say fifteen minutes) the depression is half of the original amount, then at the end of twice that period of time (thirty minutes) the depression will be one-fourth of the original amount; at the end of thrice the period of time (forty-five minutes) it will be one-eighth of the original amount, etc.

CONTAMINATION OF SURFACE WELLS.

Since the upper surface of the ground water in the surface zone of flow is everywhere exposed to contamination by seepage of impurities

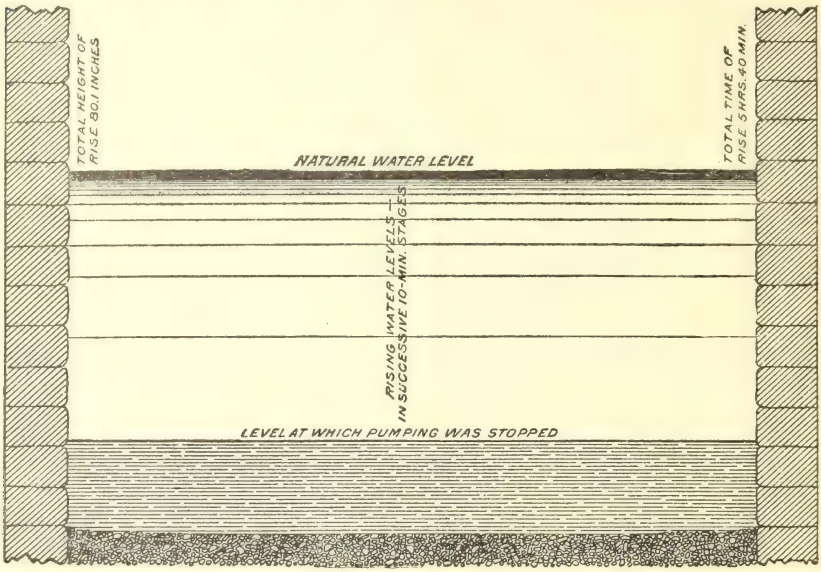


Fig. 33.—Diagram showing rise of water in city well at Garden, Kans., after heavy pumping.

from the surface of the ground, wells in this zone of ground waters are especially subject to pollution.

The organic impurities—such as decaying vegetable and animal matter, and the products of their decomposition, animal excreta,

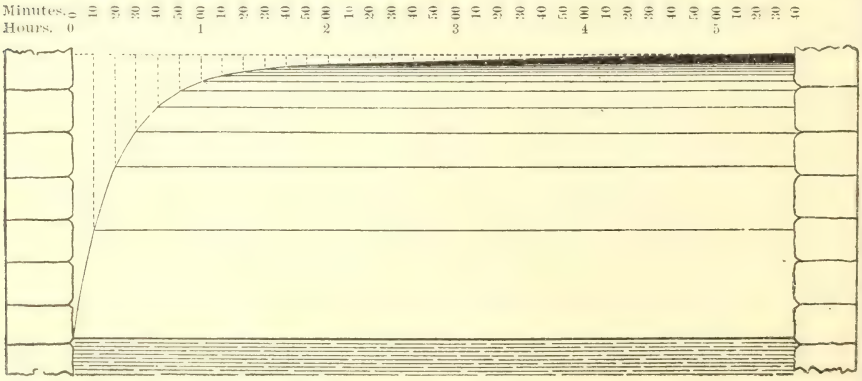


Fig. 34.—Curve showing rise of water surface in well at Garden, Kans.

especially disease germs common to such matter, etc.—constitute the most dangerous elements in drinking water. The possibility of such contamination can frequently be avoided by a proper location of the well. The slope of the ground will usually give an indication of the

direction in which the ground water is moving, and sources of contamination above the well can therefore be foreseen. It is true, however, that the depression of the water table in the immediate vicinity of the well will permit it to draw impurities from all directions, especially in the dry months, when the depression extends considerable distances. In the thickly settled districts of cities and villages it is extremely difficult to locate surface wells so that they will not be polluted to a greater or less extent.

Contamination from cesspools is much more dangerous than contamination from surface filth, for the upper few feet of the soil contain living organisms which purify and destroy organic impurities slowly seeping downward, while the organic matter in cesspools is immediately contributed to the subsoil without the action of the nitrifying organisms. The author has noted 18 cases of typhoid fever in one district of a city, the families drawing their water from 18

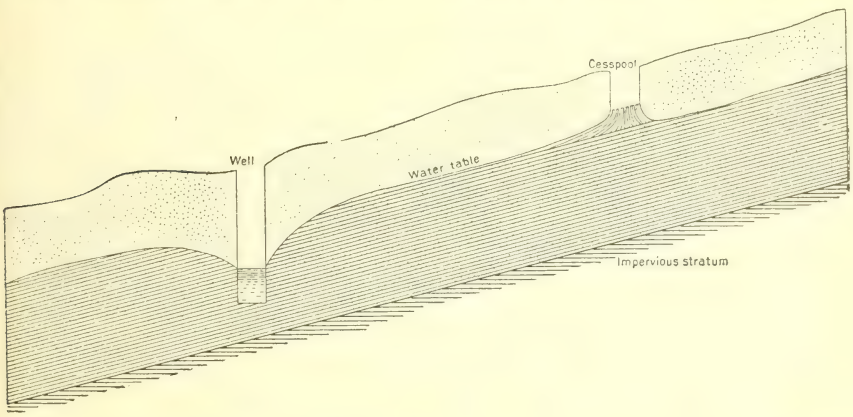


FIG. 35.—Diagram illustrating danger of contamination of surface wells from cesspools.

neighboring wells. The city was built upon the slope of a river terrace, and the alternation of wells and cesspools was essentially as illustrated in fig. 35. In this particular case pure artesian water from flowing wells could have been had by drilling about 1,000 feet.

NONUNIFORMITY OF NEIGHBORING WELLS.

It is a not uncommon experience to find that water can not be obtained a short distance from a good well. Such a discovery always causes considerable comment, while the large regions in which ground water is found at very uniform depths call forth no comment whatever. Irregularities in the strata, especially in the deposits of clay in the glacial drift, account for most of the observed diversity of supply. Fig. 36 illustrates an extreme form of irregularity which was observed in East Schleswig-Holstein. By the action of the ice and drift in Glacial times this formation was so thrown together that there were formed in the soil a number of trough-shaped and irregular

cavities which have been filled with permeable glacial sand. These troughs or cavities have collected ground water at various depths into masses which are only in partial communication with one another. In fact, the ground water is for the most part separated into distinct streams of greater or less size, which are in communication with one another only during high water. A–G, fig. 36, represent wells whose water levels, on account of these conditions, show a great variety of height, and some of which, as at G, have no water in dry weather. Another cause of irregularity in the depth and supply of wells is found in localities where gravelly beds of ancient streams or the beaches of former lakes lie buried beneath a later formation of surface material. These lines of gravel are usually very narrow, but may extend for miles in a sinuous course, or in a gently curving course, as the case may be that of a buried stream or a buried lake.

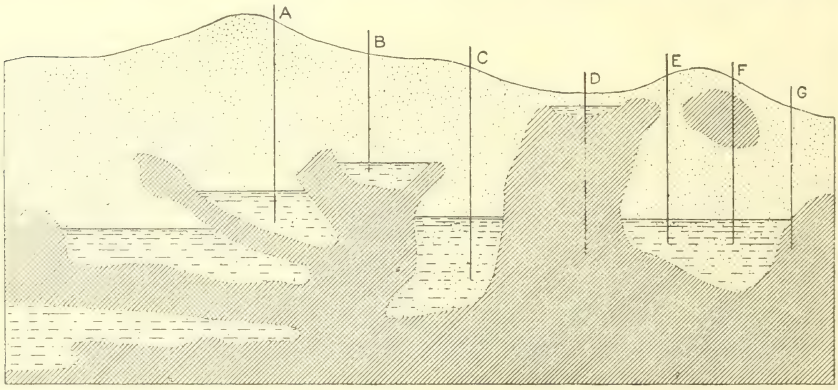


FIG. 36.—Diagram showing extreme irregularities of the water table and the depth of wells (A, B, C, etc.) in East Schleswig-Holstein. (After Haas.)

FLUCTUATIONS IN THE POSITION OF THE WATER TABLE AND THE EFFECT ON WELLS AND SPRINGS.

The height of the water table is constantly subject to variation. Its position at any time is dependent upon the varying relations between rainfall and evaporation. The influence of the former upon the position of the water table can readily be ascertained by actual measurement. There will be observed, of course, not only variations corresponding to single rainstorms, but variations from the rainy months to the dry months and from rainy years to dry years, etc. The average position of the water table at Munich, determined from observations made in three wells and extending over a period of thirty years, is shown in fig. 37.[a] A similar diagram for the city of Berlin, made from observations in thirty-seven wells and extending over sixteen years, is shown in fig. 38. Everyone is familiar with the common experience of the low stage of water in wells during dry months or

[a] The diagrams are taken from the article by I. P. Gerhardt in Der Wasserbau, Leipsic, Vol. I, Pt. I, p. 47.

exceptionally dry years, which is caused by fluctuations in the water table like those represented graphically in these diagrams.

Changes in the barometer produce interesting changes in the position of the water table and still greater changes in the flow of springs and wells.

Observations show that the flow of springs and wells increases with a lowering of the barometer. This phenomenon has been carefully noted from early times, accurate descriptions dating from the eighteenth century. Baldwin Latham, in 1881, gave the results of some very interesting observations in England. He reports that some of

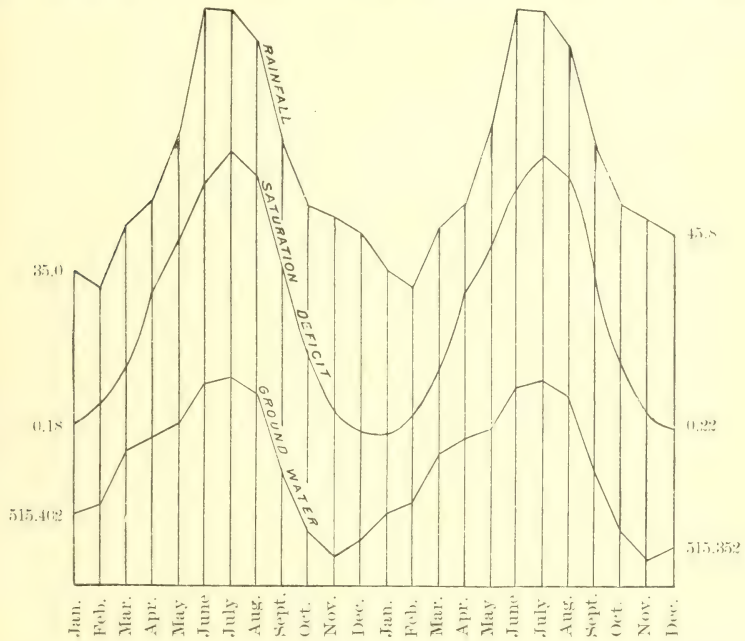


FIG. 37.—Diagram showing fluctuation of the height of the ground water and associated phenomena as observed at Munich. Averages are for thirty years and from observations in three wells. Ground water and rainfall are in centimeters, saturation deficit in millimeters. The saturation deficit indicates the amount of water lacking for the complete saturation of the air at the prevailing temperature.

the long-established millers on the chalk streams claimed that they were able to foretell the approach of a rainstorm by a sensible increase in the flow of the river before any rain had fallen. He undertook a series of observations to investigate the phenomenon, and found, by setting up gages in the spring of 1881, on the Bourne, in the Caterham Valley, near Croydon, and selecting periods when there was no rain to vitiate the results, that whenever there was a rapid fall in the barometer there was a corresponding increase in the volume of water flowing, and that with a rise in the barometer there was a diminution in the flow. The fluctuations in the flow of the Croydon Bourne, due to barometric pressure, at one period exceeded 500,000 gallons a day.

Observations upon the yield of wells and springs and upon percolation gages gave similar evidence. In 1883 Latham made observations on the effect of barometric pressure upon the flow of water from artesian wells, with results in accordance with the other observations.[a] Similar results were later observed in Germany and in America.[b] (See fig. 39.)

The phenomenon is usually explained by the expansibility of the air confined in the porous medium in the neighborhood of the ground water and of the air dissolved in the ground water itself. Even the air in the soil above the water table meets more or less resistance to its escape when the barometer falls, and consequently a differential

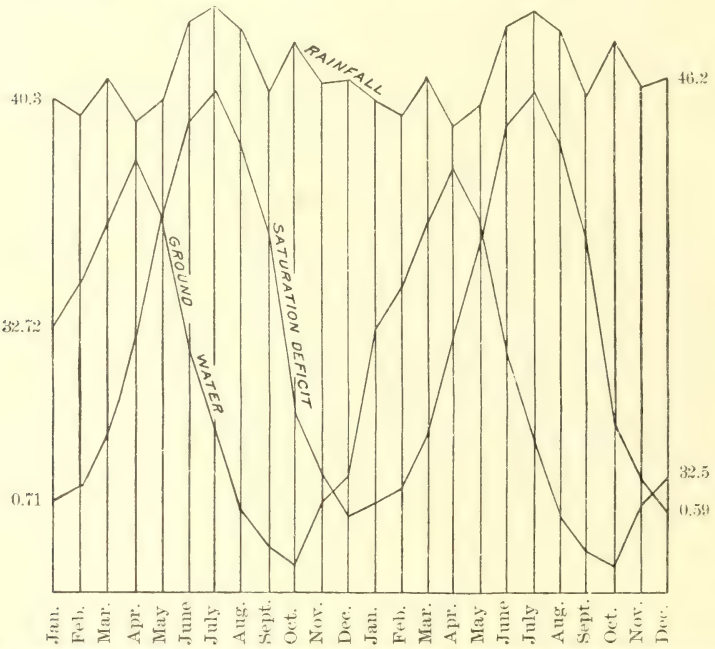


FIG. 38.—Diagram showing fluctuation of the height of ground water and associated phenomena as observed at Berlin. Averages are for sixteen years and from observations in thirty seven wells. Ground water and rainfall are in centimeters, saturation deficit in millimeters.

pressure must exist over the surface of the water table and the surface exposed at the well or spring.

A change of an inch in the height of the barometer corresponds to a change of pressure of about 1 foot of water. It is evident that such a differential pressure exerted over the surface of the water table is sufficient to materially affect the flow into wells and springs.

A very unique and not uncommon phenomenon, due to the same cause, is the "blowing" of wells just before a storm, as has been observed in the West. The low barometer before a storm causes

[a] See British Association Reports, 1881, p. 614; 1883, p. 495.

[b] Einfluss des Atmosphärendrucks auf die Ergiebigkeit von Brunnen und Quellen, by Otto Lueger: Centralblatt d. Bauverw., 1882, p. 8. F. H. King, U. S. Dept. Agr. Weather Bulletin No. 5, 1892, p. 50.

large quantities of air to be forced from the well with a loud, roaring noise.

AVAILABLE SUPPLY OF WELLS AND SPRINGS.

We may summarize the conditions affecting the amount of ground water available for the supply of wells and springs as follows: (1)

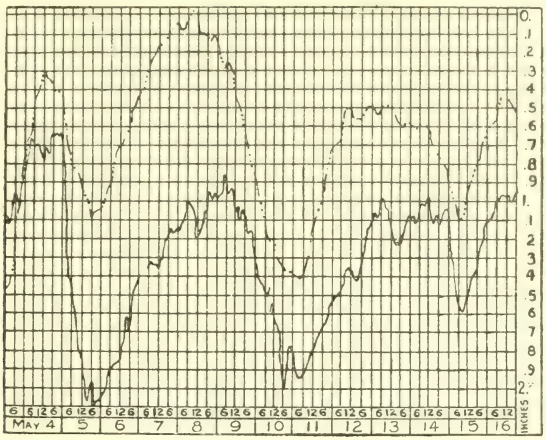


FIG. 39.—Autograph record of simultaneous changes in flow of spring and atmospheric pressure. Upper curve is air pressure, lower curve flow of spring. (After F. H. King.)

Magnitude of the area contributory to the wells; (2) amount of the rainfall upon this area; (3) geologic structure, such as (*a*) the arrangement or stratification of the material, (*b*) the breadth and depth of the water-bearing medium, and (*c*) the character or composition of this material, such as its fineness and porosity; and (4) physiographic features of the land surface, such as mountains, plateaus, hills, valleys, plains, forests, prairies, cultivated areas, etc.

COLLECTING GALLERIES AND SUBCANALS.

Another method of obtaining water from the surface underflow of ground water is by excavating a ditch or tunnel, with its bottom

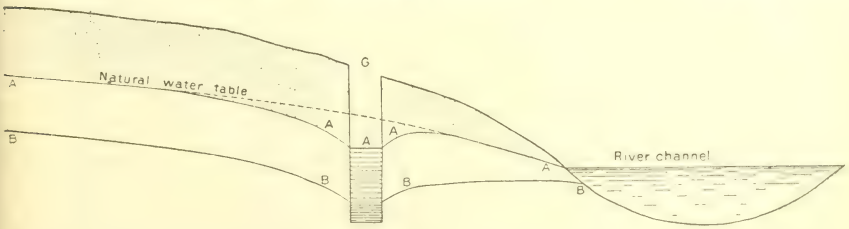


FIG. 40.—Diagram illustrating Salbach's theory of the contamination of wells or collecting galleries by reversed flow from rivers. Liability of contamination begins, according to Salbach when the water table falls so as to intersect the bed of the stream, as it does at B B B B.

below the water table, and running as nearly as possible at right angles to the direction of the underflow. A ditch so constructed is

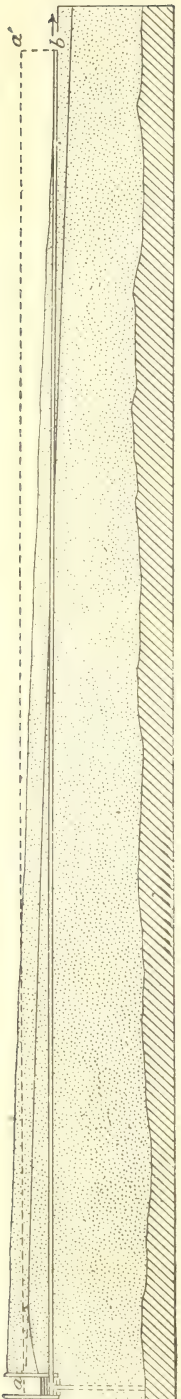


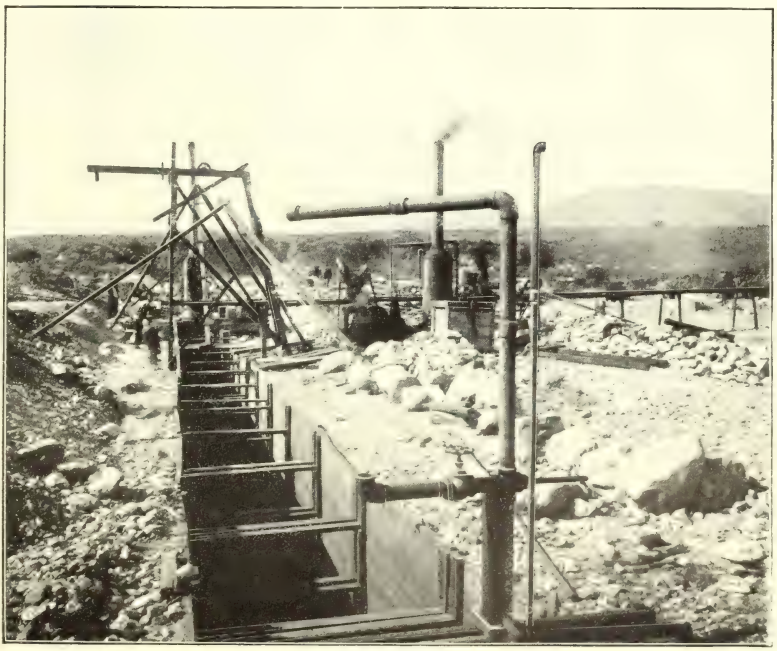
FIG. 41.—Diagram illustrating principle involved in construction of infiltration galleries for gravity flow, by Willard D. Johnson.

nothing but a very elongated surface well. Its great length often makes it possible to bring the water to the surface of the ground without pumping, by simply extending the ditch with a slope less than that of the surface of the ground until the flow comes to the surface. When such a channel is excavated for the purpose of furnishing a city water supply, it is usually called a collecting or infiltration gallery. Such excavations may be either open and unwalled or covered and walled. A variety of terms have been applied by various authors to similar devices constructed for obtaining water for irrigation. The open ditches are called gravity cuts, fountains, and underflow canals, the first term applying especially when the recovery is made without pumping. If the water is secured by tunneling or "mining" for water, the excavation is frequently called a subsurface canal or underflow tunnel.

Several gravity cuts and tunnels made in the porous gravels so common in California have yielded water in abundance. Fountains constructed in material having a relatively low transmission constant, while not furnishing water for irrigation works of great magnitude, have, nevertheless, been important factors in many localities. The yield of a fountain or infiltration gallery, like the capacity of a well, must depend very largely upon the character of the water-bearing material in which the excavation is made, the yield being proportionate to the transmission constant. Other things being equal, the yield must be nearly proportional to the length of the canal. The depth is likewise an important factor. Theoretical considerations indicate that the flow should be proportional to the square of the depth of the water surface in the canal below the natural water table. This conclusion seems to be borne out by experience.

The usual practice in recovering underflow by means of gravity works is to follow a grade much less than the slope of the ground surface until the floor of the canal is about 6 feet below the level of ground water, and then to follow, in the further excavation from that point, the same slope as the surface of the ground. It is obvious that

A. VIEW LOOKING UP THE PACOIMA WASH FROM THE SITE OF THE SUBSURFACE DAM.



B. VIEW OF 50-FOOT SECTION OF SUBSURFACE DAM ON THE PACOIMA WASH SHOWING EXCAVATION AND LAGGING.

gravity works are impracticable where the ground water is at great depths or where there is an insignificant slope to the water table.

The effect of the removal of ground water from the soil by means of an infiltration gallery is, of course, the lowering of the water table in the immediate vicinity of the excavation. The curved form assumed by the water table is approximately that shown in figs. 8 (p. 29) and 40 (p. 73), and is similar to the form of the water table in the neighbor-

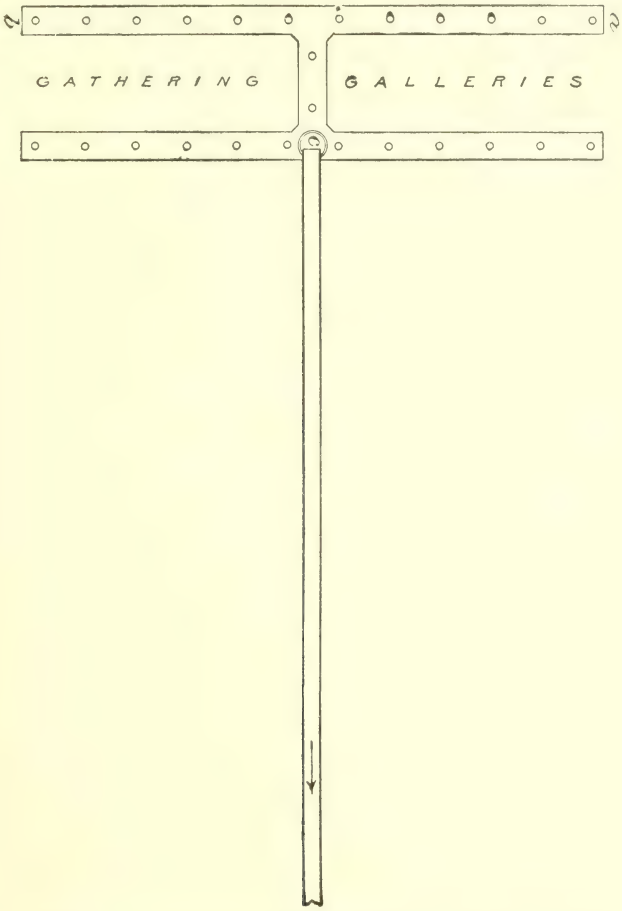


FIG. 42.—Plan of infiltration galleries proposed by Willard D. Johnson.

hood of a well. If the infiltration gallery is constructed in close proximity to the bank of the river, and if the water collected is used for a city water supply, it is important to know under what circumstances pollution may take place by seepage of river water into the gallery. According to Salbach such pollution will not take place unless the curved water table actually intersects the bed of the stream, as shown by B B B B in fig. 40.

Disappointment has sometimes followed the construction of infiltra-

tion works of the types described, especially in regions of low rainfall or where the underflow had not previously been subjected to careful survey. The underflow cut above Dodge, Kans., is now entirely abandoned. The supply of water was disappointing and the river floods have filled the excavation, which was dredged at great expense, with silt and sand.

Mr. Willard D. Johnson has made important suggestions for the construction of infiltration galleries for gravity works, as shown in the accompanying figures (41, 42, and 43). He would use one or more batteries of tubular wells to reach the best portions of the water-bearing medium, as shown by a careful survey made prior to the construction of the works. The best flow of water is usually

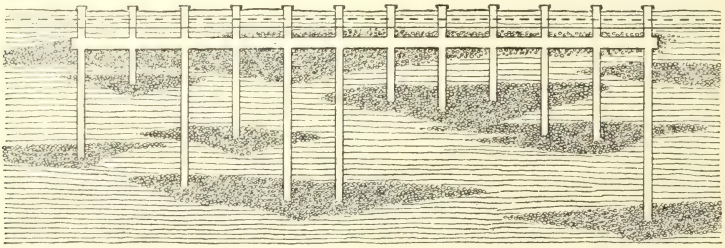


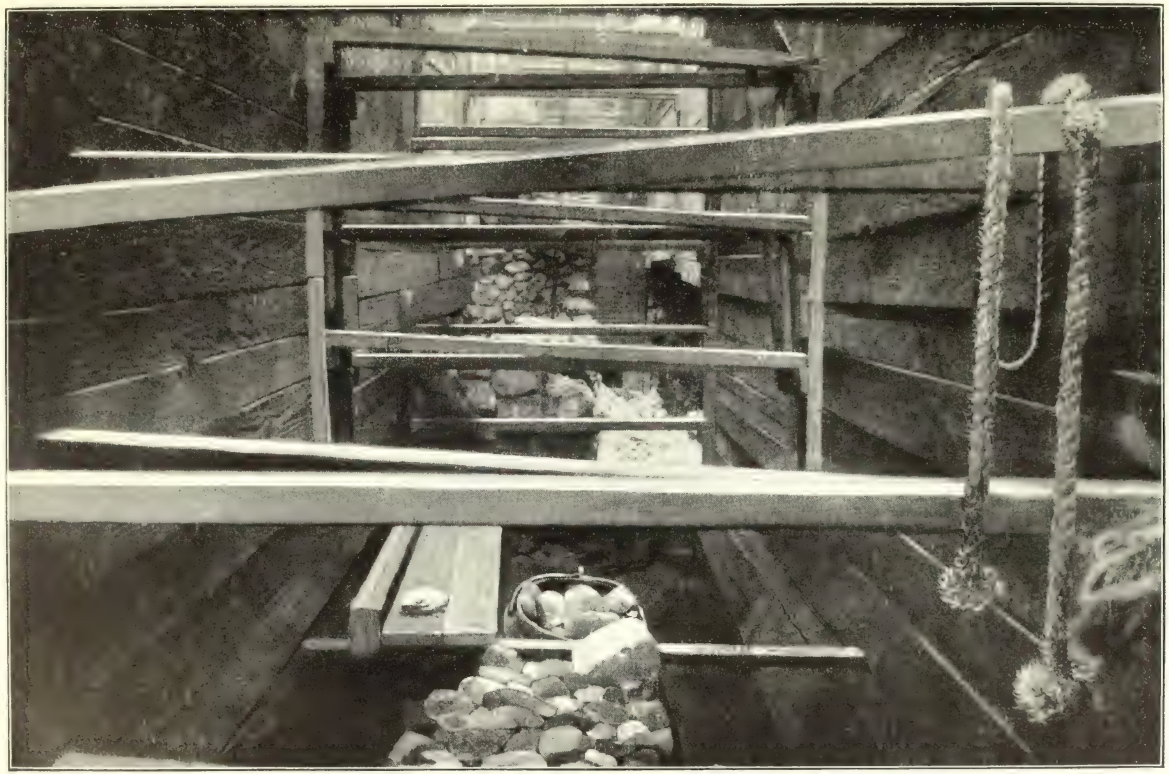
FIG. 43.—Longitudinal section of infiltration galleries designed by Willard D. Johnson.

found at a considerble depth below the water table, and Mr. Johnson's plan offers a simple way of reaching it without expensive excavation.

SUBSURFACE DAMS.

Another method of recovering the underflow of a stream is by means of a subsurface dam. Such a dam is constructed by excavating a trench at right angles to the direction of the underflow and extending in depth to the impervious stratum, and then filling the trench with impervious material. If the underflow is confined within an impervious trough or canyon, it is obvious that such a construction must result in bringing it to the surface. An example of this is found on Pacoima Creek, Los Angeles County, Cal., where a subsurface dam was constructed in 1887–1890. It is claimed that by means of this dam the owners have been enabled to use the bed-rock flow of water for the three dry years, 1898–1900, and thereby to successfully carry through the orange, lemon, and olive growing in Fernando Valley. This dam is described in the Eighteenth Annual Report of the United States Geological Survey, Part IV, pages 693 to 695; also in Reservoirs for Irrigation, Water Power, etc., by James D. Schuyler, 1901, page 205.

A view of the wash up the canyon from the site of the dam is shown in Pl. V, A. An underflow was known to exist, as the stream had a good perennial flow back in the hills, shown in the background of



VIEW FROM BOTTOM OF 50-FOOT SECTION OF PACOIMA SUBSURFACE DAM SHOWING LAGGING IN PLACE AND CONSTRUCTION OF CONCRETE WALL.

Pl. V, *A*, which was observed to gradually sink into the deep gravel wash before reaching the plains. At the site of the dam the canyon walls are about 600 feet apart, and the rock floor is at irregular depths, generally from 25 to 50 feet below the surface of the gravel.

In constructing the dam, a trench was excavated in successive sections at right angles to the course of the wash. Each section was 50 feet long and 5 feet wide, as shown in Pl. V, *B*. The excavation extended to bed rock and was boarded up with 2-inch by 8-inch by 8-foot timbers and lagged with 3-inch by 4-inch by 5-foot timbers, as shown in Pl. V, *B*, and Pl. VI. When bed rock was reached, a small trench about 12 inches deep and 10 inches wide was excavated in it, and the construction of the cement and gravel dam was begun. The wall is about 2 feet thick, and was built up to the surface in the usual manner, loose surface material being replaced around the dam as built, completely inclosing and supporting it. Centrifugal pumps kept the trenches free from water while working at bed rock, except at the closing section. Two masonry collecting wells were built in the wall of the dam, as a part of the same structure and extending to bed rock. The wells are 4 feet in internal diameter, and are built heavy on the downstream side, but lighter and with a number of openings to admit water on the upstream side.

As constructed, the dam shuts off the underflow, with the exception of some leakage which developed in places, the dam not being completely water-tight. The underground reservoir formed in the upstream gravel can not be definitely outlined, but its surface area is about 300 acres. The water is collected by means of four lines of 10-inch to 12-inch concrete tile pipes laid above one another in horizontal rows from 8 to 10 feet apart on the upper side of the dam, beginning within a few feet of the bed rock. The tiles are in 3-foot lengths, laid with open joints, and discharge into the collecting wells described.

A distributing main is laid into each well about 10 feet below the surface, and is bent down inside of the well so as to take water about 30 feet below the surface. These mains are 14 and 20 inches in diameter, and extend underground to the towns of San Fernando and Pacoima, furnishing water for irrigation and domestic use.

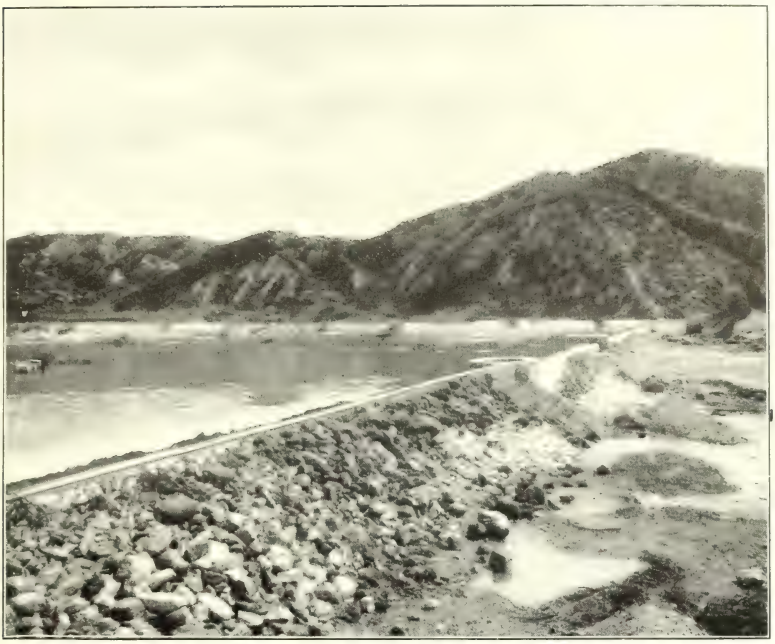
The end sections of the dam were carried up about 2 feet higher than the central portion, so as to prevent an overflow of water cutting out the banks of the wash. The total cost of the structure was about $40,000, cement costing $5 a barrel and labor from $2 to $4 a day. The top of the completed dam is shown in Pl. VII, *A*, and a portion of the central section in Pl. VII, *B*.

ADVANTAGES OF UNDERGROUND SUPPLY.

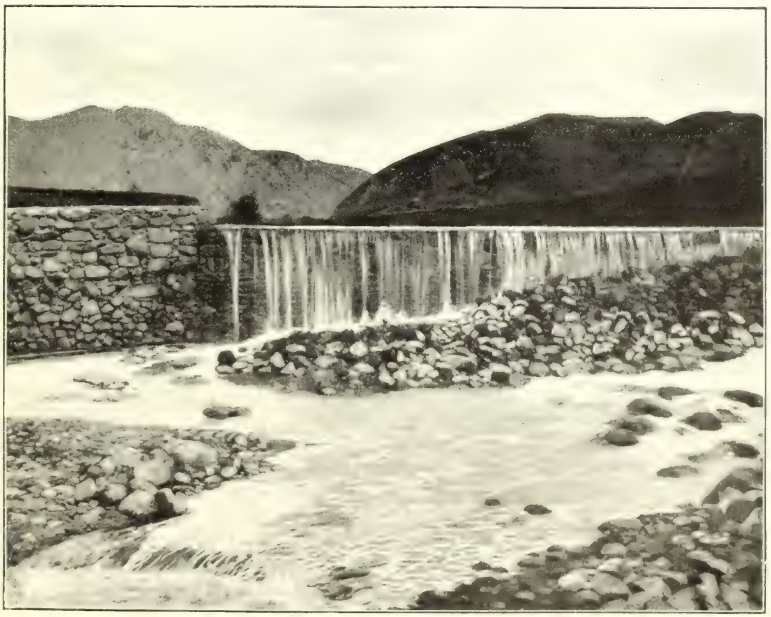
The recovery of ground water for irrigation by pumping from wells or by means of gravity cuts, infiltration galleries, or submerged dams is, considering the amount of water recovered, more complicated and

expensive than the common practice of using the perennial flow of surface streams. But as the waters of the streams become more and more appropriated other sources of supply must be sought. The principal alternatives are the storage of storm waters and the utilization of the underflow. The appropriation of the perennial flow of the rivers by the mountain States leaves the settlers along the valleys of the Great Plains dependent upon the underground waters for irrigation. Fortunately portions of western Kansas and Nebraska are supplied with underground water within a reasonable distance from the surface. While the size of underflow works must be small in comparison with the usual works of stream diversion or reservoir storage, yet there are compensating advantages associated with them which make their development especially worthy of encouragement where conditions are favorable. In the first place, the utilization of the underflow is making use of water which in most cases would otherwise go to waste. Frequently the underflow drawn from the alluvium of a river is completely replaced by return seepage of river water during flood stages of the stream, so that the sands and gravels are really being used as inexpensive and indestructible reservoirs for the storage of storm waters. In the second place, there is usually greater regularity and uniformity in the quantity of ground water than there is in the perennial flow of rivers, although the former is by no means free from the influence of dry months and dry seasons, as has already been shown. Furthermore, irrigation by the use of windmills or other power along the river valleys of the Plains, even if practiced on a small percentage of the area, must have an appreciable effect in raising the level of the water table, in turn augmenting the acreage which can be cultivated and irrigated, and increasing the percentage of the rainfall which will enter the soil. The combination of intensive farming on small irrigated tracts with cattle raising on adjoining natural grass lands would seem to indicate a most attractive future for vast portions of the Great Plains and to contain possibilities of unique economic and social interest.

The fundamental disadvantage in the utilization of underground sources of water is the danger of overdrawing the natural supply. In regions in which the rainfall is light and catchment areas are small as in parts of southern California, it is easy to extend development of underground sources so as to greatly exceed the natural rate of annual replenishment. In this way underground reservoirs are depleted which have been ages in filling; principal as well as interest is drawn upon, and much disappointment must inevitably follow.



A. VIEW OF TOP OF COMPLETED SUBSURFACE DAM ON THE PACOIMA WASH, SHOWING WELLS ON UPPER SIDE OF SAME



B. VIEW OF CENTRAL PORTION OF SUBSURFACE DAM ON THE PACOIMA WASH DURING OVERFLOW

CHAPTER V.

ARTESIAN AND DEEP WELLS.

In Chapter III several ways in which the water from the deep zones may again reach the surface have been pointed out. If outcrops of the porous stratum exist at lower levels than the exposures which constitute the receiving or catchment area, we may expect to find associated with them numerous springs and diffused return seepage. In places the covering rock may be defective or locally pervious, so that, if the pressure be great enough, water from the deep zone may reach the surface, or at least pass into a higher zone of flow. Occasionally joints and faults in the overlying rocks give opportunity for deep springs to show themselves. In some places the association of deep springs with the faulting system of the covering rocks is a phenomenon of great persistency. Dr. Peale, in his report on the mineral waters of the United States, remarks the almost universal association of mineral and thermal springs with the faulting of rocks.[a] Prof. W. H. Hobbs, who has made a study of the faulting system of the Pomperaug Valley, Connecticut, has kindly furnished a map (fig. 44, on next page) showing the association of springs and faults in that region. By referring to the map it will be noticed that the springs not only occur along the line of faults, but usually occur where two, three, or more faults intersect. "The Triangle" shown on the map is a swampy area caused by the dropping of a triangular block of surface rock left unsupported by three lines of faults. It is undoubtedly supplied by seepage around its margin. It is described in Professor Hobbs's paper in the Twenty-first Annual Report of the United States Geological Survey, Part II.

The springs arising from the deep zones of flow are usually distinguished from surface springs by a greater constancy of flow from season to season and by a greater uniformity in the summer and winter temperatures of the water. Many surface springs are found to dry up and permanently disappear with the settlement and deforesting of the country, but this phenomenon is much less common with deep springs. The deep springs are also much less liable to contamination than surface springs, for reasons which are very obvious. Even if the source of the deep zone of flow be polluted, the time required for the water to reach the outlet at the spring is usually so great that all organic impurities are effectually broken down and oxidized.

---

[a] Fourteenth Ann. Rept. U. S. Geol. Survey, Pt. II, 1894, p. 49.

In order to artificially recover water from the deep zone of flow, it is obvious that it must first be reached by drilling through the overlying material, the practicability of which depends upon the character and thickness of the covering rock and the expense which it is feasible to incur for the purpose. If the water in the water-bearing stratum is found under high pressure, it will rise in the drill hole until the pressure head due to the weight of the water column just balances the pressure in the water-bearing rock, or, if the pressure be

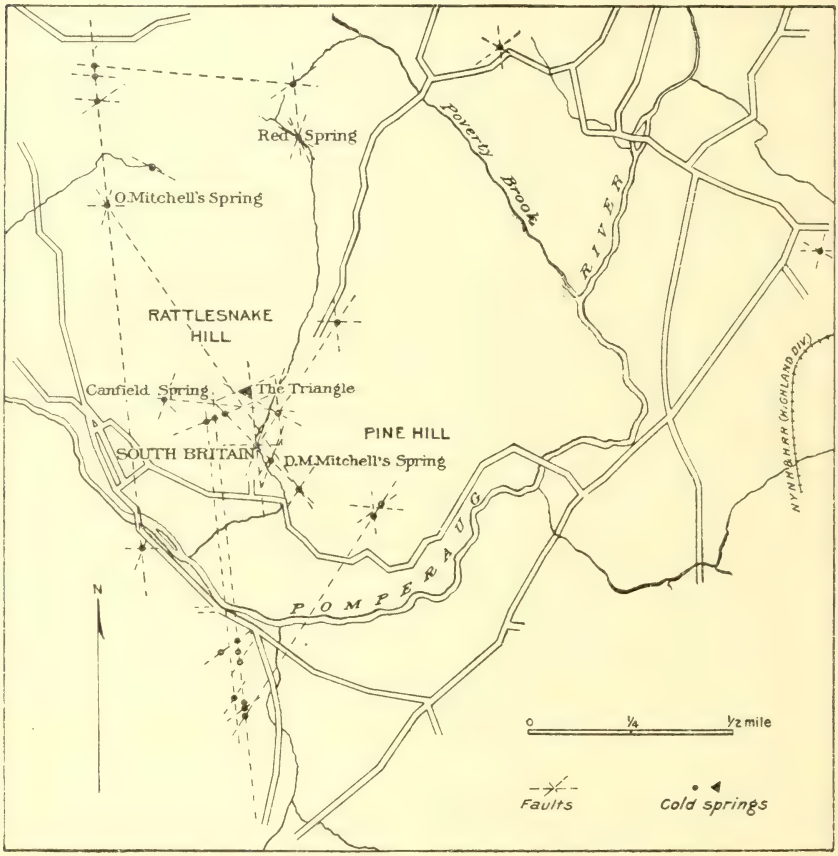


FIG. 44.—Map showing location of springs in the vicinity of South Britain, Conn.

great enough, until the water actually overflows above the surface. In order, however, that the water may rise as high as possible, it is necessary that the drill hole be properly cased with suitable well tubing, so that there will be no opportunity for the escape of water into pervious beds above the water-bearing rock; otherwise the drill hole may serve merely as a passage way from a lower to a higher stratum.

If the water actually overflows at the surface of the ground, we have an artesian well, properly so called. If the water does not rise

to the surface, we have a nonflowing or deep well. This distinction is an important one to the owner of the wells, for in one case water is obtained without the constant expenditure of work and the wear and tear of pumping machinery, while in the other case a continual expenditure of work and money is required to bring the water to the surface. In the explanation of the phenomena and of the difficulties to be met with and overcome the distinction is one of little consequence and is entirely disregarded by many writers. The determination of the question whether or not a given well will overflow depends upon the altitude of the top of the well; so that of two wells exactly alike in all respects except that one is drilled on higher ground than the other, both tapping the same water-bearing rock, the one may overflow while the other may not. For this reason many writers call both wells artesian, and distinguish them as flowing and nonflowing wells. If the adjectives flowing and nonflowing are used, we may designate as artesian any well made into a deep zone of flow where the water is found under a static pressure so that it will rise in the well above the impervious covering stratum. The essential differences between such a well and a surface well are due to the existence of the upper impervious stratum, which is absent in the surface zone of flow. Owing to the presence of this impervious cover, we may emphasize the following distinguishing characteristics between surface wells and artesian wells: (1) The water in the water-bearing veins of an artesian well is under a static pressure and will rise when the impervious cover is penetrated, while the ground water supplying a surface well has a free upper surface which is lowered and changed in shape when water is removed from the well; and (2) an artesian well is supplied by the rainfall of districts not in the immediate vicinity of the well, but often distant hundreds of miles, while a surface well draws upon the rainfall of the immediate vicinity.

The conditions upon which the existence of artesian wells depends presupposes a knowledge of the principles involved in the motion and storage of underground waters in the deep zones of flow. The essential facts involved in such flow have been discussed in Chapter III. The diagram of the cross section of the Dakota artesian basin (fig. 20, p. 55) will serve to illustrate the conditions present in any artesian basin. In that diagram it will be noticed that the high elevation of the western exposure of the porous Dakota sandstone in the Black Hills tends to give a high pressure to the water in the sandstone in its eastern and nearly horizontal portion. If there were absolutely no escape for the water to the east of the catchment area, we should expect the water to rise in each well, if the casing were extended high enough, to the horizontal line L-L′ (fig. 20). The actual observed pressure, however, departs widely from that line, due undoubtedly to leakage from the eastern outcrop of the sandstone, especially along

the Missouri and Great Sioux rivers in the southeastern part of South Dakota. At Running Water, Randall, and Chamberlain springs are seen rising from the bed of Missouri River, which probably accounts for the tendency to lower pressure in the neighborhood of the river. The high pressure at Kimball, Plankinton, and other places east of Chamberlain, probably reaches these points in part by a more northerly route, along which the loss by seepage is less than at Chamberlain and southerly points. This is verified by the high pressure of 205 pounds at Cheyenne Agency and by a pressure of more than 180 pounds at Crow Creek Agency, the latter place being halfway between Chamberlain and Pierre, and the pressure higher than is found at either of those places.

As already stated, the essential features of an artesian basin are well illustrated by this example of the Dakota area. The same principles are involved in the Potsdam and St. Peter artesian basin in southern Wisconsin and northern Illinois, and in the other large artesian basins in the country, except that the high pressure and large yield of the Dakota wells are in excess of those common in other basins. For a more extensive discussion of the general principles involved the reader is referred to Prof. T. C. Chamberlin's paper entitled, The Requisite and Qualifying Conditions of Artesian Wells.[a] The principal conditions on which artesian flows depend are summarized by Chamberlin as follows:

I. A pervious stratum to permit the entrance and the passage of the water.

II. A water-tight bed below to prevent the escape of the water downward.

III. A like impervious bed above to prevent escape upward, for the water, being under pressure from the fountain-head, would otherwise find relief in that direction.

IV. An inclination of these beds, so that the edge at which the waters enter will be higher than the surface of the well.

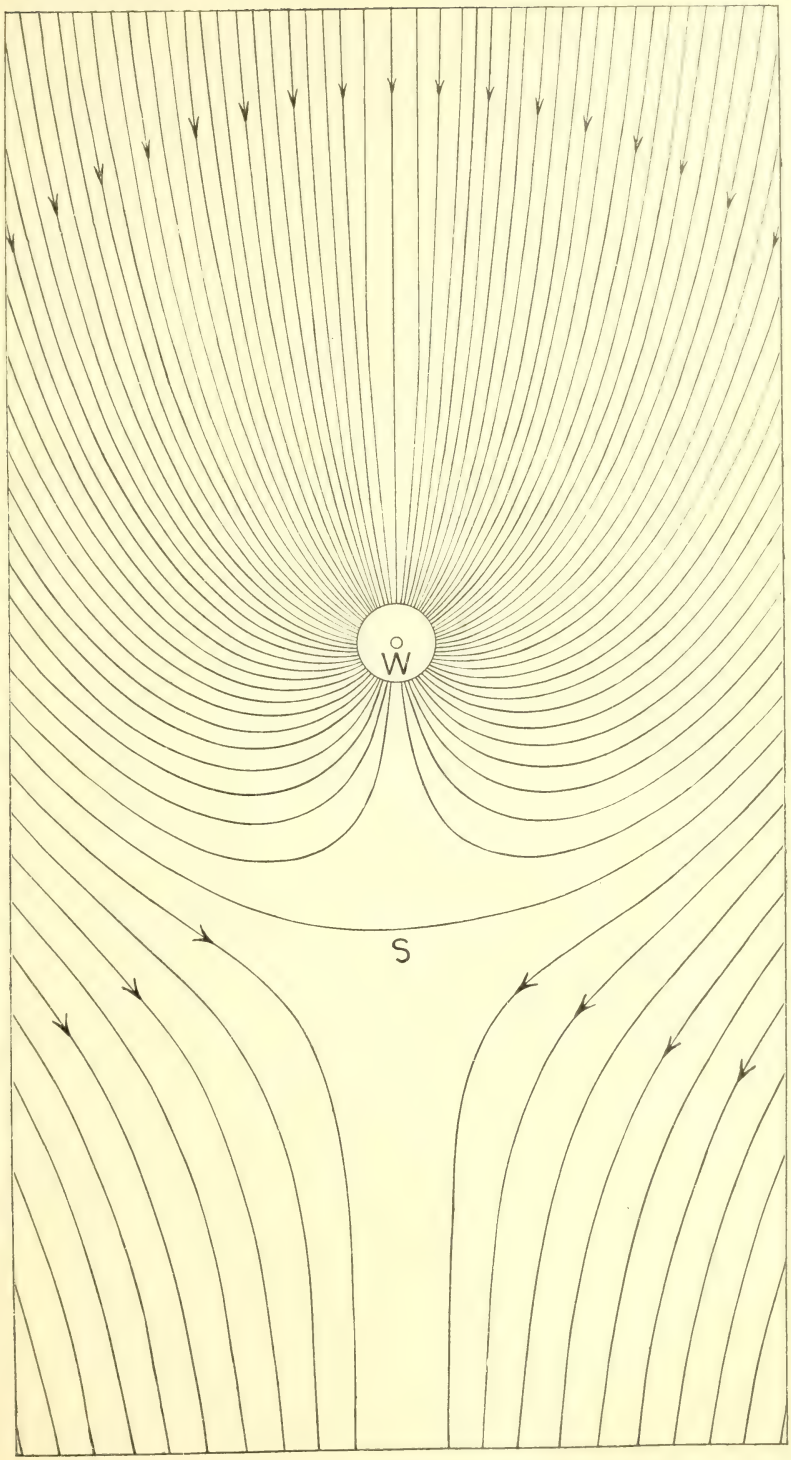
V. A suitable exposure of the edge of the porous stratum, so that it may ta in a sufficient supply of water.

VI. An adequate rain-fall to furnish this supply.

VII. An absence of any [*easy*] escape for the water at a lower level than the surface at the well.

These seven prerequisites as stated by Chamberlin have been widely quoted by various writers and have become classic. The writer has made no change in the statements except the substitution of the word "easy" for "any" in VII, which is undoubtedly in accord with the meaning intended by Professor Chamberlin. Of course the less opportunity there is for the water of the water-bearing rock to escape at a level below that of the well the higher will be the head of pressure at the well, but the water-bearing stone is usually so fine that the frictional resistance offered by it to the movement of the water is sufficient to establish considerable pressure a few miles back from an outcrop. As water flows through a horizontal porous medium under a head at

[a] Fifth Ann. Rept. U. S. Geol. Survey, 1885, pp. 131-173.



LINES OF FLOW INTO A WELL IN A REGION IN WHICH THE GROUND WATER HAS A CONSTANT MOTION IN A GENERAL DIRECTION.

one end, the pressure gradually drops from the maximum value at the end at which the water enters to nothing at the free end from which the water flows. This is illustrated by fig. 45. If we should prevent the escape of water at K_7 G_2, it would rise to corresponding heights (H′, H″, H‴) in all of the tubes. In spite of the free escape at the right end of the sand column K_7 G_2, the pressure gradient H_1 H_2 H_3 H_4 H_5 H_6 is sufficient to produce a flow at any point along the tube K_1 K_6 if the wall of the tube be punctured. In this case we may imagine that the water-bearing sand and its confining tube represent, respectively, the water-bearing stratum and the upper and lower impervious strata of an artesian basin, the water column at the left of the figure corresponding to the higher outcrop of the pervious

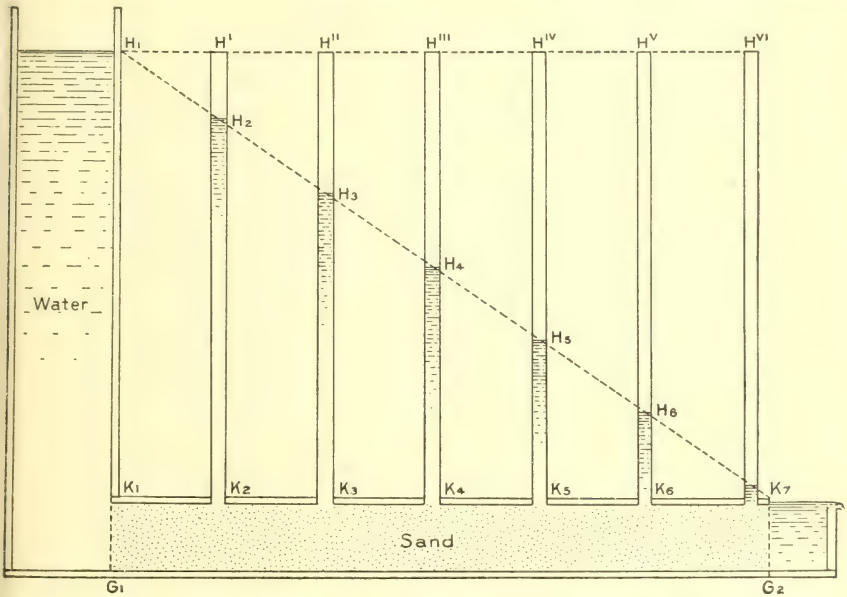


FIG. 45.—Diagram illustrating the fall of pressure as water moves through a pervious material.

rock in the catchment area, while a puncture made in the tube anywhere between K_1 and K_7 represents an artesian well.

The general character of the lines of flow in the neighborhood of an artesian well is shown in Pl. VIII.

YIELD OR CAPACITY OF ARTESIAN WELLS.

The yield of an artesian well, or the amount of water delivered in a given time, is usually measured in cubic feet per minute or per second, or in gallons per twenty-four hours. The yield depends upon the same factors as noted in Chapter IV, on surface wells, but in addition to the causes there enumerated as affecting the flow in common wells, we must now consider the frictional resistance which the

water suffers in flowing through the casing and drill hole of the well. This resistance increases with the length of the casing, and also increases very rapidly with a decrease in the diameter of the casing. For long pipes the following formula will give the approximate discharge in cubic feet per minute:

$$q=378\sqrt{\frac{d^5h}{fl}},$$

in which d is the diameter of the pipe in feet; l is the length of the pipe in feet; h is the head under which the flow takes place, measured in feet of water; f is the friction factor, which depends for its value upon the character of the surface of the pipe, and varies with the size of the pipe and the velocity of flow (for rough approximations its mean value 0.02 can be used).

The foregoing formula states that the discharge from a long pipe varies directly as the $2\frac{1}{2}$ power of the diameter of the pipe, directly as the square root of the head, and inversely as the square root of the length of the pipe. The discharge of pipes, however, is ordinarily taken directly from hydraulic tables, thus saving the labor of computation.[a] If we attempt to estimate by the formula or by a hydraulic table the discharge from the well tubing of a flowing well, using as the head the observed static head when the mouth of the well is closed, and using the known size and depth of the well and tubing for the diameter and length of the pipe, a result will be obtained which will always be found to be in excess of the actual flow from the well. The reason for this is that no account is taken of the enormous resistance offered to the flow of water into the well through the pores of the water-bearing strata. The amount of water yielded by the porous strata to the well can also be expressed by a formula, as the writer has shown in another paper.[b] In order to estimate the amount of water delivered by the porous medium its transmission constant must be known. Suppose this constant to be given, the following is the formula which expresses the yield of the well, neglecting, as already stated, the resistance due to pipe friction:

$$Q_0=\frac{2\pi h k a}{\log_e\left(1+\frac{1,200}{D}\right)}\text{ cubic feet per minute,}$$

in which h is the observed static head, in feet, a is the thickness of the water-bearing stratum (of transmission capacity k), and D is the diameter of the well in feet. The logarithm used here is the natural

---

[a] See Tables Showing Loss of Head Due to Friction of Water in Pipes, by E. B. Weston, Van Nostrand, N. Y., 1896; and Graphical Solution of Hydraulic Problems, by F. C. Coffin, Wiley & Sons, New York, 1897.

[b] Theoretical investigation of the motion of ground waters: Nineteenth Ann. Rept U. S. Geol. Survey, Pt. II, 1899, p. 360.

or napierian logarithm.[a] The denominator of the fraction in this formula is the only part that depends for its value upon D, the diameter of the well. This part of the formula, namely, $\frac{1}{\log_e\left(1+\frac{1,200}{D}\right)}$, changes value but slightly as D is changed. This fact is readily understood when we remember that 2 inches and 12 inches are the practical limits of size of artesian wells. In Table VII are written the various values which this expression takes for certain common sizes of wells. It is seen that the values differ but slightly for the various sizes, so that if friction in the pores of the sandstone be the only resistance that need be considered the capacity of such wells would be but slightly dependent upon the diameter of the well.

TABLE VII.

Values for various diameters of wells of the factor in artesian-well formula which depends upon the diameter of the well.

Diameter of well.	Value of $\frac{1}{\log_e\left(1+\frac{1,200}{D}\right)}$	Compared with value for 6-inch well.
Inches.		
2	0.1125	0.876
3	0.1179	0.918
4	0.1220	0.951
4½	0.1238	0.964
5	0.1254	0.977
6	0.1283	1.000
8	0.1333	1.039
9	0.1354	1.055
10	0.1374	1.070
12	0.1408	1.097

The formula for the actual flow from the well must take account of both the resistance offered by the water-bearing medium and the resistance due to pipe friction. The writer finds that the following formula is the expression of the actual yield of the well, if both of these factors are taken into account:

$$Q = q\left(\sqrt{1+\frac{q^2}{4\,Q_o^2}} - \frac{q}{2\,Q_o}\right) \text{ cubic feet per minute,}$$

in which q is the estimated free discharge of water through the well and casing under head h, including in the estimate the influence of all valves, bends, reduction in size of pipe, etc., and Q_o is the theoretical yield of the well under head h, if friction in the well and pipe be neglected. In this expression Q_o varies only slightly with a change in the diameter of the well, while q varies rapidly for such change.

[a] This formula was obtained by the writer in 1892. While the paper referred to was in press he discovered that substantially the same formula had been previously worked out by a German hydrographer.

Table VIII gives values of Q_0, or the theoretical yield of an artesian well, computed for various effective sizes of grains of the water-bearing medium. The table is calculated on the basis of a 6-inch well and 100 feet thickness of water-bearing strata. Other thicknesses of strata and other heads of pressure will give proportional results. Such a table may be found useful in estimating the yield of wells in unconsolidated sands of known character, but of course it must not be expected to give results of very great refinement. A nicety of numerical results is impracticable in such a subject, and the table, to be of value, must be used with discretion.

TABLE VIII.

Theoretical capacity (no allowance for pipe friction) of 6-inch artesian well extending 100 feet in materials of various kinds for various heads of pressure.

[Proportional yields for other heads and other thicknesses of material. Yields for wells of other diameters can be obtained by the use of the last column of Table VII. Porosity, 32 per cent; temperature, 50° F.]

Effective size of grain.	4-foot head.	8-foot head.	10-foot head.	12-foot head.	16-foot head.	25-foot head.	Conventional names of size of grains.
Mm.	*Cu. ft. per min.*	*Cu. ft. per min.*	*Cu. ft. per min.*	*Cu. ft. per min.*	*Cu. ft. per min.*	*Cu. ft. per min.*	
0.02	0.047	0.093	0.116	0.140	0.186	0.291	Silt.
0.04	0.186	0.372	0.465	0.558	0.744	1.163	
0.06	0.419	0.837	1.047	1.256	1.674	2.616	Very fine sand.
0.08	0.744	1.488	1.860	2.233	2.977	4.651	
0.10	1.163	2.326	2.907	3.492	4.652	7.270	
0.12	1.675	3.350	4.186	5.025	6.700	10.46	Fine sand.
0.14	2.279	4.558	5.697	6.837	9.116	14.24	
0.16	2.977	5.954	7.440	8.931	11.91	18.60	
0.18	3.768	7.536	9.419	11.30	15.07	23.55	
0.20	4.651	9.302	11.63	13.95	18.60	29.07	
0.25	7.266	14.53	18.17	21.80	29.06	45.47	
0.30	10.46	20.92	26.16	31.38	41.84	65.41	Medium sand.
0.40	18.60	37.20	46.51	55.80	74.40	116.3	
0.50	29.07	58.14	72.67	87.21	116.3	181.8	
0.60	41.86	83.72	104.7	125.6	167.4	261.6	Coarse sand.
0.70	56.96	113.9	142.4	170.9	227.8	356.1	
0.80	74.42	148.8	186.0	223.3	297.7	465.1	
0.90	94.19	188.4	235.5	282.6	376.8	588.7	
1.00	116.3	232.6	290.7	349.2	465.2	726.7	
2.00	465.1	930.2	1163.0	1395.0	1860.0	2907.0	Fine gravel.
3.00	1046.0	2092.0	2616.0	3138.0	4184.0	6541.0	

The writer has devised the following graphical method of solving problems connected with the capacity of artesian wells, and has found it to be very useful. We will first apply the method to a problem in which it is supposed that we know the theoretical yield of the well when pipe friction is neglected (that is, the value of Q_0 from Table VIII), and the value of the theoretical discharge (q) of the well tube under the given static head, which last may be taken from a hydraulic table, as already suggested. In fig. 46, let AB and BC be each laid off equal to Q_0, so that $AC=2Q_0$. Then lay off CD at right angles to AC and equal to q. Join AD and lay off $DE=CD$ and draw CE. Also lay off $AF=CD$ and draw FG parallel to CE and make

$AH=AG$. Then $AH=Q$, the total actual yield of the well. The line HB represents the loss of flow due to friction in the well and casing. If the well and casing were larger, CD would be longer, and likewise AH and AG would be greater, so that the flow Q would be increased.

As a numerical example of this graphical construction, suppose that the water-bearing stratum is 100 feet thick, of effective size grain 0.2 mm., and that the static head is equal to a 50-foot column of water. Let us determine the yield of a 4-inch well 1,000 feet deep. From Table VIII we find that $Q_o=55.3$ cubic feet per minute. On page 98 of Weston's hydraulic tables the discharge of 1,000 feet of 4-inch pipe under a head of 50 feet is found to be about 257 gallons per minute, or 34.3 cubic feet per minute, so that $q=34.3$. Draw $AB=BC=55.3$ and also $CD=34.3$. Making the construction indicated, we get AH or $Q=24.6$ cubic feet per minute, which is some-

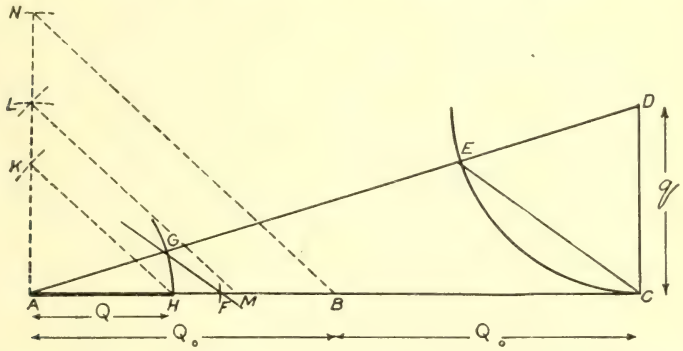


FIG. 46.—Diagram illustrating the author's graphical solution of problems in the yield of artesian wells.

what less than half of the theoretical yield, with pipe friction neglected.

Uncertainty as to the value of k, or the transmission constant of the rock, makes the application of this graphical solution more or less uncertain so far as precision of results is concerned. Nevertheless, it is capable of giving much valuable information concerning the relations of the two fundamental causes affecting the capacity of wells, pipe friction, and capillary friction in the pores of the rock.

Perhaps the most useful application of the method is to the inverse problem of determining the value of Q_o, or the theoretical flow, when the static head and the actual discharge of the well have been measured. The value of Q_o can be found graphically in the following manner, as is shown by the dotted lines in fig. 46: Lay off on any straight line, AC, the known yield of the well, or $Q=AH$. Draw the line $AKLN$ perpendicular to AH, and from H as center describe an arc with radius equal to q, cutting AN in K. Then lay off

$AL=HK=q$, and draw LM parallel to KH. Next lay off $AN=LM$ and draw NB parallel to HK. Then AB is Q_o, or the theoretical flow of the well if pipe friction were entirely absent.

The usefulness of the inverse solution lies chiefly in the fact that it enables us to determine the increased yield which results from enlarging the diameter of a flowing well. Thus let us suppose that a 4-inch well 1,000 feet deep yields 26.6 cubic feet per minute under a static head of 50 feet; what yield should we expect from a 6-inch well, all other things being similar? We first lay off $AH=24.6$ in fig. 46, and make the construction shown by the dotted lines. This gives us $AB=55.3$, so that the yield of the 4-inch well, if pipe friction could be avoided, would be 55.3 cubic feet per minute.

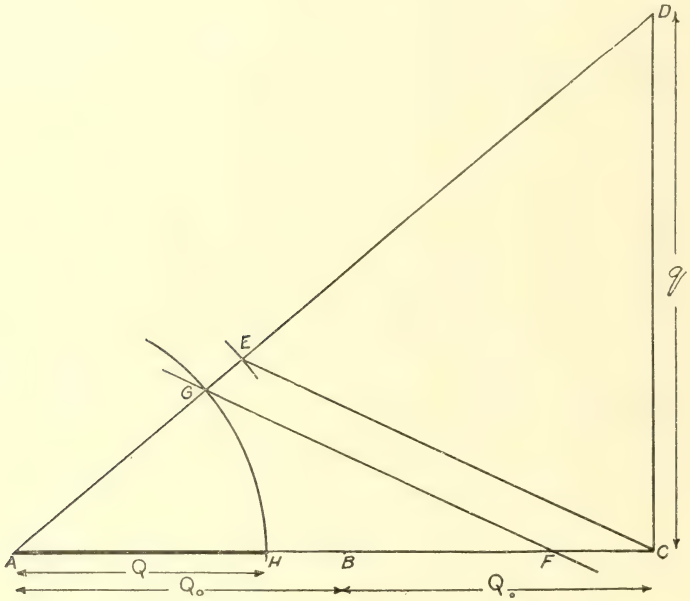


FIG. 47.—Diagram illustrating graphical solution of an artesian-well problem.

From Table VII, column 3, we observe that this value should be increased about 5 per cent if the diameter of the well be changed to 6 inches. This gives us 58.1 cubic feet per minute for Q_o for a 6-inch well. The discharge of 1,000 feet of 6-inch pipe under a head of 50 feet is found on page 102 of Weston's tables to be 730 gallons, or 97.3 cubic feet, per minute. Then in fig. 47 lay off $AB=BC=58.1$ and $CD=97.3$. Following the construction explained, we arrive at the value of Q or AH, which is found to be 45.6. Therefore the yield of a 6-inch well will be 45.6 cubic feet per minute. The yield of the 4-inch well was 24.6 cubic feet per minute, so that a 6-inch well under these conditions should be expected to have a capacity about 85 per cent greater than that of a 4-inch well.

The foregoing problems may also be solved by means of the curves of fig. 48. These curves show the relation of Q, the discharge of a well, to Q_o, the theoretical yield, but on a scale in which the unit of discharge is equal to q, the capacity of the well tube under the given static head. In order to illustrate the use of the diagram, we shall use the same examples that we have just solved. The first problem calls for the yield of a 4-inch well 1,000 feet deep whose static head is 50 feet, the transmission constant and thickness of water-bearing stratum being given as before. Table VIII gives the theoretical yield $Q_o=$ 55.3 cubic feet per minute. From a hydraulic table the capacity of

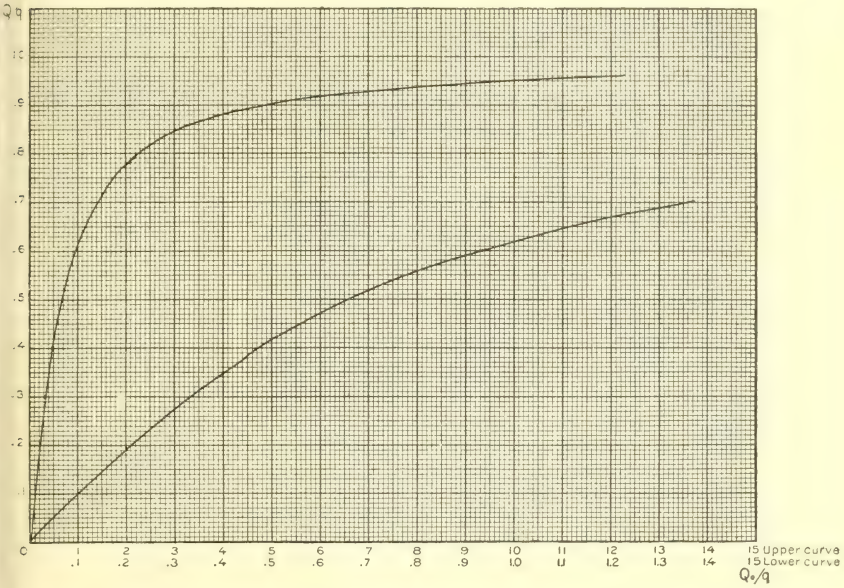


FIG. 48.—Graphical representation of the relations between Q and Q_o in the equation on page 85, q being taken as equal to unity. The lower curve is a replat on larger scale of the portion of the upper curve between $Q_o=0$ and $Q_o=1.35$. From this diagram the value of Q_o can be obtained when Q and q are given. The unit of measure is $q=1$, so that Q must always be less than unity on this scale. In other words, the ordinates in the diagram are equal to Q/q, the abscissas to Q_o/q.

1,000 feet of 4-inch pipe under a head of 50 feet is found to be 34.3 cubic feet per minute. Using this value of q as the unit of measure gives $Q_o/q=55.3\div34.3=1.6$. Finding this value on the horizonal scale of the diagram (fig. 48), we determine Q/q to be 0.725. To reduce to cubic feet per minute, multiply 0.725 by 34.3, the value of q, which gives 24.9 cubic feet per minute as the yield of the well. The result is slightly different from that obtained by the graphical construction.

The same diagram can also be used to solve the inverse problem previously discussed: If a 4-inch well 1,000 feet deep, having a static head of 50 feet, yields 24.6 cubic feet per minute, what will be the

yield of a 6-inch well under the same conditions? From a hydraulic table we obtain, as before, the yield of 1,000 feet of 4-inch pipe, viz, 34.3 cubic feet per minute. This is the value of q. Then Q/q is $24.6 \div 34.3$, or 0.72. Finding 0.72 in the vertical scale of the diagram (fig. 48) gives $Q_0/q=1.55$. According to Table VII this should be increased about 5 per cent in order to give the value of Q_0/q for a 6-inch well, making its value 1.63, so that $Q_0=1.63 \times 34.3$, or 56 cubic feet per minute. A hydraulic table gives q for 1,000 feet of 6-inch pipe, head 50 feet, equal to 97.3 cubic feet per minute, so that for a 6-inch well $Q_0/q=56 \div 97.3=0.60$. Using the lower curve of fig. 48, we find corresponding to 0.60 that $Q/q=0.47$, and since $q=97.3$, $Q=97.3 \times 0.47=45.7$, which is the yield of the 6-inch well in cubic feet per minute.

SIMPLE METHODS OF MEASURING THE YIELD OF FLOWING WELLS.

Prof. J. E. Todd, State geologist of South Dakota, has recently issued a bulletin describing very simple methods of determining the yield of an artesian well, which give fairly accurate results with little trouble and in a short time. The following tables and explanations are from his bulletin. All that is necessary for the purpose is that the water be discharged through a pipe of uniform diameter, a foot rule, still air, and care in taking measurements. Two methods are proposed, one for pipes discharging vertically, which is particularly applicable before the well is permanently finished, and one for horizontal discharge, which is the most usual way of finishing a well.

The table below is adapted to wells of moderate size as well as to large wells. In case the well is of other diameter than that given in the table its discharge can without much difficulty be obtained from the table by remembering that, other things being equal, the discharge varies as the square of the diameter of the pipe. If, for example, the pipe is one-half inch in diameter its discharge will be one-fourth of that of a pipe 1 inch in diameter for a stream of the same height. In a similar manner the discharge of a pipe 8 inches in diameter can be obtained by multiplying the discharge of the 4-inch pipe by 4.

In the first method the inside diameter of the pipe should first be measured, then the distance from the end of the pipe to the highest point of the dome of the water above, in a strictly vertical direction—a to b in the diagram, fig. 49. Find these distances in the table (IX, A), and the corresponding figure will give the number of gallons discharged each minute. Wind would not interfere in this case, so long as the measurements are taken vertically.

The method for determining the discharge of horizontal pipes requires a little more care. First, measure the diameter of the pipe, as before, then the vertical distance from the center of the opening

of the pipe, or some convenient point corresponding to it on the side of the pipe, vertically downward 6 inches, *a* to *b* of the diagram, then from this point strictly horizontally to the center of the stream, *b* to *c*. With these data the flow in gallons per minute can be obtained from the table (IX, B). It will readily be seen that a slight error may make much difference in the discharge. Care must be taken to measure horizontally and also to the center of the stream. Because of

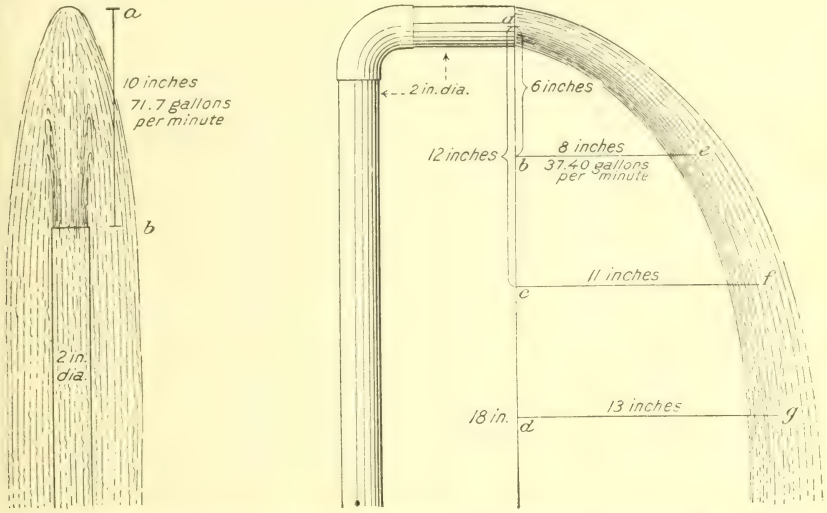


FIG. 49. Diagram illustrating flow from vertical and horizontal pipes.

this difficulty, it is desirable to check the first determination by a second. For this purpose columns are given in the tables for corresponding measurements 12 inches below the center of the pipe. Of course the discharge from the same pipe should be the same in the two measurements of the same stream. Wind blowing either with or against the water may vitiate results to an indefinite amount; therefore measurements should be taken while the air is still.

TABLE IX.

Table for determining yield of artesian wells.

A. Flow from vertical pipes.

Height of jet.	Discharge in gallons per minute. Diameter of pipe in inches. 1	1¼	1½	2	3
Ins.					
½	3.96	6.2	8.91	15.8	35.6
1	5.60	8.7	12.6	22.4	51.4
2	7.99	12.5	18.0	32.0	71.9
3	9.81	15.3	22.1	39.2	88.3
4	11.33	17.7	25.5	45.3	102.0
5	12.68	19.8	28.5	50.7	113.8
6	13.88	21.7	31.2	55.5	124.9
7	14.96	23.6	33.7	59.8	134.9
8	16.00	25.1	36.0	64.0	144.1
9	17.01	26.6	38.3	68.0	153.1
10	17.93	28.1	40.3	71.6	161.3
11	18.80	29.5	42.3	75.2	169.3
12	19.65	30.7	44.2	78.6	176.9
13	20.46	31.8	45.9	81.8	184.1
14	21.22	33.0	47.6	84.9	190.9
15	21.95	34.2	49.3	87.8	197.5
16	22.67	35.2	50.9	90.7	203.9
17	23.37	36.3	52.5	93.5	210.3
18	24.06	37.5	54.1	96.2	216.5
19	24.72	38.6	55.6	98.9	222.5
20	25.37	39.6	57.0	101.6	228.5
21	26.02	40.6	58.4	104.2	234.3
22	26.66	41.6	59.9	106.7	240.0
23	27.28	42.6	61.4	109.2	245.6
24	27.90	43.5	62.8	111.6	251.1
25	28.49	44.4	64.1	114.0	256.4
26	29.05	45.3	65.3	116.2	261.4
27	29.59	46.1	66.4	118.2	266.1
28	30.08	46.9	67.5	120.3	270.4
29	30.55	47.5	68.5	121.9	274.1
30	30.94	48.2	69.4	123.4	277.6
36	34.1	53.2	76.7	136.3	306.6
48	39.1	61.0	88.0	156.5	352.1
60	43.8	68.4	98.6	175.2	394.3
72	48.2	75.2	108.0	192.9	434.0
84	51.9	81.0	116.8	207.6	467.0
96	55.6	86.7	125.0	222.2	500.0
108	58.9	92.0	132.6	235.9	530.8
120	62.2	98.0	139.9	248.7	559.5
132	65.1	102.6	146.5	260.4	585.9
144	68.0	106.4	153.1	272.2	612.5

B. Flow from horizontal pipes.

Horizontal length of jet.	Flow in gallons per minute. 1-inch pipe. 6-inch level.	1-inch pipe. 12-inch level.	2-inch pipe. 6-inch level.	2-inch pipe. 12-inch level.
Ins.				
6	7.01	4.95	27.71	19.63
7	8.18	5.77	32.33	22.90
8	9.35	6.60	36.94	26.18
9	10.51	7.42	41.56	29.45
10	11.68	8.25	46.18	32.72
11	12.85	9.08	50.80	35.99
12	14.02	9.91	55.42	39.26
13	15.19	10.73	60.03	42.54
14	16.36	11.56	64.65	45.81
15	17.53	12.38	69.27	49.08
16	18.70	13.21	73.89	52.35
17	19.87	14.04	78.51	55.62
18	21.04	14.86	83.12	58.90
19	22.21	15.69	87.74	62.17
20	23.37	16.51	92.36	65.44
21	24.54	17.34	96.98	68.71
22	25.71	18.17	101.60	71.98
23	26.88	18.99	106.21	75.26
24	28.04	19.82	110.83	78.53
25	29.11	20.64	115.45	81.80
26	30.38	21.47	120.07	85.07
27	31.55	22.29	124.69	88.34
28	32.72	23.12	129.30	91.62
29	33.89	23.95	133.92	94.89
30	35.06	24.77	138.54	98.16
31	36.23	25.59	143.16	101.43
32	37.40	26.42	147.78	104.70
33	38.57	27.25	152.39	107.98
34	39.64	28.08	157.01	111.25
35	40.45	28.64	161.63	114.52
36	41.60	29.46	166.25	117.79
Continue by adding for each inch—				
	1.15	0.82	4.62	3.27

NOTE.—To convert results into cubic feet, divide the number of gallons by 7.5, or, more accurately, by 7.48.

The flow in pipes of diameters not given in the table can easily be obtained in the following manner:

For ½-inch pipe, multiply discharge of 1-inch pipe by 0.25
For ¾-inch pipe, multiply discharge of 1-inch pipe by 0.56
For 1¼-inch pipe, multiply discharge of 1-inch pipe by 1.56
For 1½-inch pipe, multiply discharge of 1-inch pipe by 2.25
For 3-inch pipe, multiply discharge of 2-inch pipe by 2.25
For 4-inch pipe, multiply discharge of 2-inch pipe by 4.00
For 4½-inch pipe, multiply discharge of 2-inch pipe by 5.06
For 5-inch pipe, multiply discharge of 2-inch pipe by 6.25
For 6-inch pipe, multiply discharge of 2-inch pipe by 9.00
For 8-inch pipe, multiply discharge of 2-inch pipe by 16.00

Whenever fractions occur in the height or horizontal distance of the stream, the number of gallons can be obtained by apportioning the difference between the readings in the table for the nearest whole numbers, according to the size of the fraction. For example, if the distance from the top of the pipe to the top of the stream in the first case is 9⅓ inches, one-third of the difference between the reading in the table for 9 and 10 inches must be added to the former to give the correct result.

In case one measures the flow of a well by both methods he may think that the results should agree, but such is not the case. In the vertical discharge, there being less friction, the flow will be larger; so also in the second method differences will be found according to the length of the horizontal pipe used.

As pipes are occasionally at an angle, it is well to know that the second method can be applied to them if the first measurement is taken strictly vertically from the center of the opening, and the second measurement from that point parallel with the axis of the pipe to the center of the stream, as before. The measurements can then be read from the table.

FAILURE OF ARTESIAN WELLS.

It is not uncommon to find that the flow of an artesian well is gradually growing less or failing altogether. The cause of the failure may be purely local and pertain to that particular well, or it may be general and associated with some depreciation of the artesian basin as a whole. If the failure is due to local causes it may not be duplicated in neighboring wells, while causes affecting the artesian basin as a whole must of course be evidenced by a diminution of flow in all of the wells.

Perhaps the most common cause of failure of single wells is improper casing. Some wells are not properly cased from the beginning. Or the trouble may be due to poor jointing or packing where the casing meets the uncased rock, or to poor packing where a reduction in the size of the casing occurs. Casing is sometimes omitted where a porous stratum really requires it, or where a friable or fractured rock is subject to constant caving. The leaks around the casing or into porous strata may easily cause the total destruction of a well, or so injure it that it can be repaired only at great expense.

The filling of the lower portion of a well with sand and débris falling from an upper stratum, or brought into the well by the water, is a common cause of the falling off in the flow of an artesian well. This difficulty is easily remedied by cleaning out the débris by means of a sand pump.

Sometimes the water-bearing rock is so friable and the pressure so great that the well must be cased to the bottom and the end of the tube be driven fast into the bottom rock, the water being admitted

into the well through numerous holes drilled in the lower sections of the casing, which act on the same principle as the cylindrical screens in a common driven well.

A cause of the partial failure of wells, which is not yet thoroughly understood, is the apparent clogging of the water-bearing rock in the immediate neighborhood of the well. Whether this clogging is due to the deposit of fine silt in the pores of the rock or to a growth of microscopic plant life, or to a gelatinous deposit of iron, etc., has not, to the writer's knowledge, been ascertained in any of the cases in which the phenomenon has been observed. In the old artesian wells at Savannah, Ga., it was found that the explosion of dynamite at the bottom of the wells did not remove the difficulty. Later, in the new wells at the same city, it was found that strong back flushing of the wells—that is, the forcing of large quantities of water into them—caused a very marked restoration of the flow. This matter will be especially referred to on a later page (p. 100), where the wells at Savannah are more fully discussed.

Failure due to causes pertaining to the entire artesian basin is also rather common. It is probably true that in nearly all artesian basins the original pressure gradient in the water-bearing rock is appreciably lowered by the artificial drafts made upon the subterranean supply, with a consequent actual decrease in the capacities of the wells. A small decrease of this kind is to be expected, and it does not necessarily indicate approaching disaster to the wells. Even in the Dakota basin, which seems thus far to be quite adequate to the enormous demands made upon it, it is thought that there is evidence of a slight depreciation of the wells on higher ground, and even some wells of low pressure have ceased to flow, as at Scotland, Tripp, and elsewhere. Most wells, however, have failed but little.[a]

It must be kept well in mind that there is a limit to the amount of water that can be withdrawn from an artesian basin. There is no such thing as an inexhaustible supply in this connection. The amount of water available is limited on the one hand by the amount of rainfall upon the catchment area and the facility with which the rainfall can obtain entrance to the porous stratum, and on the other hand by the capacity of the water-bearing rock to transmit the water over long distances and diminution through leakage and seepage. These two limiting conditions are usually of sufficient magnitude to render the overdrawing of the supply a practical and present danger which should be constantly kept in mind.

One of the most striking examples of a general and gradual failure of the wells of an entire basin is presented by those at or near the city of Denver.[b] This basin was discovered in 1884, and in a few

[a] Geology and water resources of a portion of southeastern South Dakota, by J. E. Todd: Water-Supply and Irrigation Paper U. S. Geol. Survey No. 34, 1900, p. 31.

[b] See Artesian wells of Denver Basin, by G. H. Eldridge: Mon. U. S. Geol. Survey Vol. XXVII. Also see The artesian wells of Denver; a report by a special committee of the Colorado Scientific Society: Proc. Colo. Sci. Soc., Denver, Vol. I, 1883-84, pp. 76-108.

years about 400 wells had been drilled within an area extending a distance of 40 miles along South Platte River in a strip about 5 miles wide on both sides of the stream. Most of the wells were within the limits of the city itself. Many of the wells had a good pressure and strong flow when first constructed. In 1886 it was not thought that any general decrease in the flow of the wells could be detected. Between 1888 and 1890, however, a continuous decrease in the flow of the city wells took place, and by the end of the latter year all but six of the city wells had to be pumped, while numerous wells in the basin were permanently abandoned.[a]

It is thought that the cause of the remarkable failure of this basin is not lack of rainfall upon the catchment area or the size or absorption power of the latter, but the low porosity and transmission power of the water-bearing strata. It is believed that during the early years in the history of the wells the water withdrawn represented a supply stored in the rocks but not readily transported by the strata to meet the enormous draft. Van Diest estimated in 1890 that if all the wells in Denver were plugged it would be forty years before the water-bearing strata of the Tertiary of the Denver Basin would be again in the condition of saturation existing when the first well was sunk.[b]

MUTUAL INTERFERENCE OF ARTESIAN WELLS.

It is a common experience to find that the yield of an artesian well is noticeably influenced by the construction of a new well in the same neighborhood. When this phenomenon is associated with a general lowering of the water pressure throughout the region, it is more properly considered a case of partial failure of the artesian basin than a case of interference. One well may interfere with another well without the basin being subject to general depreciation. The interference of two wells, in the technical sense, is determined by a comparison of the flow of one of two wells when both are flowing freely with the flow of each well when the other is shut off. In a similar way we may determine the interference of several wells with one well.

To illustrate the distinction between the general depreciation of an artesian area and the interference of wells with one another we will consider the case presented by the Chicago wells. The large drafts made upon the various zones of supply in that district have caused the head of wells constructed in 1864 to fall about 100 feet. This would be referred to as depreciation or partial failure of the basin. But if at the time mentioned two wells had been constructed 50 feet apart, the flow of each well during the entire period of gradual depreciation would fluctuate with the shutting down or starting up of the other well. This is what is meant by interference.

---

[a] Artesian wells of Denver Basin, by G. H. Eldridge: Mon. U. S. Geol. Survey Vol. XXVII. p. 428.

[b] Ibid., pp. 426–427. See also The artesian wells of Denver: Proc. Colo. Sci. Soc., Denver, Vol. I, 1883–84, pp. 76–108.

It is more surprising to find cases in which no interference between neighboring wells can be detected than to observe cases in which it is very pronounced. The enormous 12-inch Ponce de Leon well at St. Augustine, Fla., seems to suffer no interference from a neighboring 6-inch well. The Ponce de Leon well is 1,400 feet deep and flows 10,000,000 gallons per day under a closed head of 17 pounds per square inch.[a] While a dynamo was being operated by the 12-inch well, the 6-inch well (capacity 400,000 gallons daily) was suddenly turned on and off, but the closest observation did not detect the slightest trembling of the pressure gage on the 12-inch well. The latter well, however, is much deeper than the 6-inch well, and furnished 3,000,000 gallons daily at the depth reached by the 6-inch well. This fact and the disparity in their total yield may sufficiently account for the failure to detect any interference.

At Savannah the flow from the first 7 of 12 wells arranged 300 feet apart in a straight line was observed in 1892 to be 6,500,000 gallons per day, an average of 930,000 gallons for each well, at an elevation of 8 feet above the sea. The water stood in wells Nos. 10, 11, and 12 at altitudes of 14.93, 15.96, and 16.20 feet, respectively. The total yield of the 12 wells under the same head was 9,500,000 gallons per day, an average of 792,000 gallons for each well. In 1897 a measurement of the mutual interference of these wells and the Springfield well, 2,000 feet east, was made, and it was ascertained that when the Springfield well was shut off the total flow of the 12 wells was 6,910,000 gallons per day, and that when the Springfield well was in use the flow was 7,258,000 gallons per day. The net gain from that well was, therefore, 348,000 gallons per day, which would be increased to 468,000 gallons per day if the leakage between the well and the works be allowed for. The latter quantity (468,000 gallons) is therefore the net gain due to the use of the Springfield well. The latter well, however, was actually flowing at the rate of 1,000,000 gallons per day. Therefore the 12 wells suffered a decrease of 552,000 gallons per day, which is an interference of 8 per cent due to the Springfield well. The Savannah wells are discussed more fully on the following pages.

What is reported to be interference of wells sometimes proves to be a fault largely due to defective construction. Such was in part the case at Rockford, Ill.[b] The first well drilled was 8 inches in diameter and 1,530 feet deep. The water rose about 28 feet above the ground and flowed about 1,000,000 gallons per day. Three more wells were sunk, and when all were connected with the pump the total flow was 3,000,000 gallons per day. This would indicate a mutual interference of 25 per cent. This flow was not permanent, however, and soon diminished to 2,500,000 gallons per day, while a paper mill 1 mile south of the works and at 17 feet lower elevation drilled a well

[a] Engineering News, Vol. CCLXXI, pp. 183, 328.
[b] Engineering Record, Vol. XXII, p. 7.

which affected the original yield still more. An additional well was then drilled, but, the supply failing to increase as much as was expected, an investigation was made. Well No. 1 was found to be flowing only 70,000 gallons per day at the surface and only 210,000 gallons at the place of connection. The well was recased and repacked, the result being a flow of 177,000 gallons at the surface and 400,000 gallons at the point of connection. Similar work on well No. 4 increased the delivery at the surface from 142,000 gallons to 254,000 gallons and at the point of connection to 700,000 gallons. The wells were faulty in construction, leaking considerably in the upper strata.

ARTESIAN WELLS OF SAVANNAH, GA.

One of the most carefully planned artesian water supplies of this country is that of the city of Savannah, Ga. A brief account of these wells is of much interest, not only as illustrative of an intelligently designed and well-constructed engineering work, but also because of the valuable lessons to be learned from the way in which difficulties were met and overcome as they arose. The works were planned by Mr. Thomas T. Johnston, consulting engineer, of Chicago, Ill., and the following description is taken largely from his paper in the Engineering News.[a]

Prior to 1887 the water supply of Savannah was taken from the river, but in that year 14 artesian wells were put in use (a fifteenth well being nearly ready) near the old pumping station (see fig. 50). Of these wells, 2 were 10-inch, 12 were 6-inch, and 1 was 4-inch, and not one was more than 400 feet deep. In 1888 the entire supply of the city was drawn from these wells, the total for the year being 2,135,842,000 gallons, or about 5,850,000 gallons per day. At the close of 1889 5 new wells had been put in use, the 20 wells being distributed very irregularly within a 10-acre lot. About this time, however, it became necessary to open the river supply to some extent. Experience and observation showed conclusively that the water supply was materially affected by the tide, and it was supposed that the shallowness of the wells caused a filling by sand to a greater or less extent, thus affecting the supply. But little better results were had, however, from deepening some of the wells; one of them was deepened to 1,009 feet. Two additional 10-inch wells, 502 and 505 feet deep, were connected with the old works on December 29, 1890, but in November, 1891, it was necessary to again draw water from the river. Nothing resulted from dynamiting the wells.

In June, 1891, it was found that water in well No. 1, close to the old pumping station, was 9 feet lower than in well No. 2, distant from well No. 1 about 1,600 feet, and it was determined to abandon the old wells.

---

[a] Vol. XXIX, p. 521.

Twelve new wells in a new location were finally decided upon, and 7 were put in use on December 9, 1892, and the others on March 21, 1893. The relative locations are shown on the accompanying map, fig. 50. The wells are arranged along a highway which runs nearly parallel to the ocean and some distance from the old pumping sta-

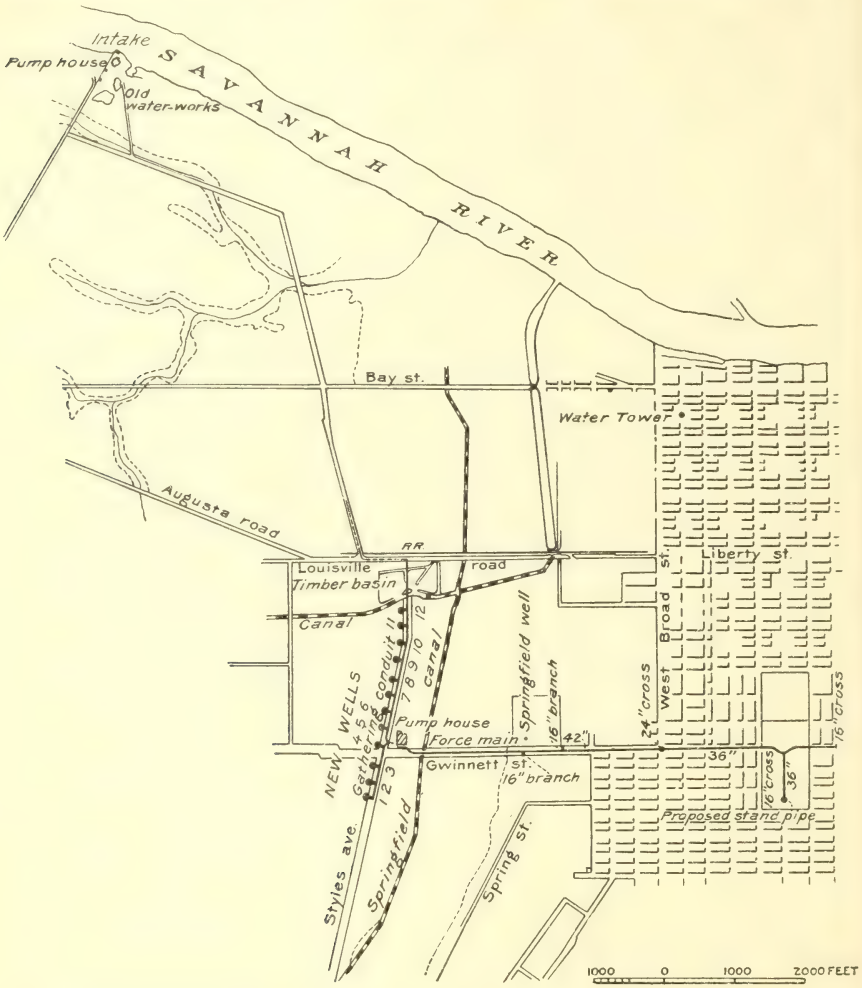


FIG. 50.—Map showing location of artesian wells at Savannah, Ga. The old wells are near the old waterworks, shown in upper left-hand corner of map. The new wells are on Styles avenue and are numbered 1-12, inclusive. (From Journal of Western Society of Engineers, Vol. II, No. 6.)

tion. They are 300 feet apart and flow into a brick and concrete conduit on the opposite side of the highway. The strata through which they are bored belong to the Cretaceous. Sands and clays were met to a depth of about 250 feet, where a cherty lime rock was found. The rock varies in character at greater depths. The first water was found at 325 feet, and the supply continually increased until the depth

exceeded 500 feet. The water-bearing rock is uniformly a porous limestone, or rather one full of cavities, very similar to the rock outcrop from which flow the mammoth Suwanee springs in northern Florida. Water is occasionally found below 500 feet, but not in sufficient quantity to justify deeper wells. The 12 wells of the new waterworks average 500 feet in depth. They are cased to the rock (about 250 feet) with casing of 12 inches internal diameter. Below this there is a 12-inch clear opening. The normal position of water in the wells, as determined by the position in the old wells when first dug, showed that it reached the static level at an elevation of 41 feet above mean low tide. Subsequent wells, bored in a wide range of country, show about the same elevation. After a number of wells had been bored the elevation of this static level was lowered. At the time of an examination in 1890 about 6,000,000 gallons per day were being pumped at the old works. The static level was then 7 feet; at the site of the new works it was at an elevation of 28 feet, while 9 miles south of the old works it was at the original elevation, 41 feet. The influence of the heavy pumpage was noticed to be greater in wells in the same line perpendicular to the shore of the ocean than in wells in a line parallel to the ocean. To predetermine the probable flow from the new wells, the Springfield well, 2,000 feet east of the new station, was examined, with the following results:[a]

TABLE X.

Flow of Springfield well, Savannah, Ga.

Elevation of static level above mean low tide.	Equivalent head.	Year.	Flow.
Feet.	*Feet.*		*Gallons per 24 hours.*
22.67	0	1890	
25.67	2.00	1890	482,000
24.40	3.27	1891	623,000
22.77	4.90	1890	1,000,000
22.68	4.99	1891	977,000
21.80	5.87	1891	1,133,000
21.79	5.88	1891	1,172,000
20.57	7.10	1890	1,360,000
13.00	14.67	1890	2,500,000

It was estimated that about 3,000,000 gallons per day could be obtained with the static head reduced to an elevation of 7 feet, which reduction is practicable at the pump house, as constructed. The old wells spread over an area about 1,700 feet wide at its largest part, and their flow at an elevation of 7 feet was about 6,000,000 gallons per day.

The first seven wells embraced a line 1,800 feet long. Reducing the level to 8 feet, the flow was 6,500,000 gallons per day. The level in wells Nos. 10, 11, and 12 was at this time 14.93, 15.96, and 16.20

[a] Section of this well is shown in Engineering News, Vol. XXX, p. 4.

feet, respectively. On March 21, 1893, the 12 wells were put into service, with elevation of water at 8 feet, and the flow was 9,500,000 gallons per day. At the beginning of 1897 the flow of the 12 wells had decreased to 6,900,000 gallons per day, and the fear was entertained that the history of the old plant was to be repeated. Mr. Johnston was again called in consultation. The results of his measurements of the flow of each of the 12 wells were as follows:

TABLE XI.

Yield of Savannah wells in 1897.

Well.	Flow.	Well.	Flow.
	Gallons per 24 hours.		*Gallons per 24 hours.*
No. 1	713,460	No. 9	399,740
No. 2	460,460	No. 10	468,650
No. 3	543,950	No. 11	371,910
No. 4	361,790	No. 12	485,760
No. 5	485,760		
No. 6	293,480		5,490,100
No. 7	452,870	Springfield well	1,019,590
No. 8	452,870		

From this table it is seen that wells Nos. 4, 6, and 11 showed a very small flow, entirely out of proportion to that of the other wells.

It having been determined that the flow of water in some wells was more obstructed than in others, the work of attempting to remove the obstructions was undertaken. The method used was back-flushing, or the forcing of a strong reverse flow back into the well. The first effort was made on well No. 2 by means of fire hose attached to a neighboring hydrant. Only a slight improvement resulted. The next attempt was made on well No. 10, fire engine No. 2 being used. But little improvement resulted. A more powerful fire engine (No. 3) was next employed, and the process was tried on well No. 6. A radical improvement was the result, the net gain in the yield of the well being 100,000 gallons per day. Encouraged by this result, the next effort was made on well No. 4, fire engines Nos. 1 and 3 being used. The result was even more radical, the net gain in yield for this well being 200,000 gallons per day.[a] The actual results on well No. 6 were as follows:

TABLE XII.

Results of flushing well No. 6, Savannah waterworks, in 1897.

	Gallons per 24 hours.
Flow before flushing:	
May 12	295,000
May 18	304,000
Flow after flushing:	
May 18	433,000
May 19	395,000
May 20	400,000
May 24	389,620

[a] Report of Thos. T. Johnston to chairman of water commission, Savannah, Ga., dated May 24, 1897.

After these experiments Mr. Johnston recommended that a special 8-inch water main of the city system be laid along the row of 12 wells, and that it be connected to each well by means of a 6-inch pipe and gate. By opening a gate any well can now be flushed at any time, and Superintendent Kinsey of the waterworks states that all of the wells have been flushed and tested regularly every year since Mr. Johnston's tests in 1897. The following is the record of the test for the year 1900:

Results of flushing Savannah wells in 1900.

	Gallons per 24 hours.
Yield before flushing	5,104,275
Yield after flushing	5,850,878
Gain	746,603

The yield before flushing given above is 385,825 gallons less than the total yield before flushing in 1897.

The results at Savannah are especially valuable on account of their reliability and the fulness of the information. In the first place, the yield of the wells can be closely relied upon, for they were determined by a special current meter designed by Mr. Johnston, which can at any time readily be lowered into one of the wells. In the second place, it was found by actual measurements at the old waterworks that there had been no lowering of the water table during the years 1892 to 1897, as the measurements made in the two years were in substantial accord. Thus the depreciation of the wells must be referred to the clogging of the pores in the rock in some unknown way, and not to a general depreciation of the basin.

Reliable data upon which to base discussion of artesian phenomena are not common. Most of the round-number estimates of yield, such as 500,000 or 1,000,000 gallons per day, are not even approximations of the actual facts.

INDEX.

Page.

Ableman, Wis., sandstone from, porosity of ... 16
Alford, N. C., reference to ... 42
Argyle, Wis., sandstone from, sections of ... 20
Arizona, underground flow in, rate of ... 26
Artesian well, view of ... 62
Artesian wells at Savannah, Ga., yield of ... 96, 97–101
  conditions necessary to ... 82
  failure of ... 93–95
  general discussion of ... 79–83
  mutual interference of ... 95–97
  yield of ... 83–90
    methods of measuring ... 90–93
Ashland, Wis., sandstone from, porosity of ... 16
Berlin, Germany, fluctuations of water table at, diagram showing ... 72
Berlin, Wis., granite from, porosity of ... 16
Bradfield, S. A., reference to ... 42
Bridgeport, Wis., limestone from, porosity of ... 16
Buckley, E. R., porosities determined by ... 16
  reference to ... 21
Building stone, porosities of ... 16
Cache la Poudre River, growth of ... 45–46
  diagram showing ... 44
Canals. *See* Subcanals.
Carpenter, L. G., cited on underflow ... 42
  work of ... 44
Cesspools, contamination of wells by ... 68–69
Chalon, ——, cited on position of thalweg ... 33
Chamberlin, T. C., quoted on requisite conditions for artesian wells ... 82
Channel, underground, view of, plate showing ... 32
Chlorine method of determining rate of underflow, curve obtained in ... 47
  description of ... 46–48
Clay loams, porosity of ... 17
Coffin, F. C., reference to ... 84
Contamination of wells from cesspool, diagram illustrating ... 69
  discussion of ... 68–69
  from rivers, diagram showing ... 73
Dakota artesian basin, map of ... 57
Dakota formation, catchment area of, map showing ... 57
  flow in, rate of ... 26
  water in, discussion of ... 57–59

Page.

Dam, subsurface, on Pacoima Wash, views of ... 74, 76, 78
Dams, subsurface, discussion of ... 76, 77
Darcy, H., laws of flow formulated by ... 18
Darton, N. H., cited on flow in Dakota formation ... 26
  map by ... 57
Deep zones of flow, discussion of ... 52–60
  distinguishing features of ... 53–54
  percolation into ... 54–57
Delesse, A., estimate of underground water by ... 15
Deltas of disappearing streams, map showing ... 38
Denver, artesian wells near, failure of ... 94
Disappearing streams, deltas or fans of, map showing ... 38
Ditch, water table near, shape of ... 29
Dodge, Kans., flow, underground, at, rate of ... 26
Drinker, H. S., cited on water in St. Gothard tunnel ... 16
Dug well, figure showing ... 63
Dug and tubular well, figure showing ... 67
Dunnville, Wis., sandstone from, porosity of ... 16
Echo River, Mammoth Cave, size of ... 31
Effective size of soil grains, determination of, methods of ... 22–23
  variations in velocity of flow based on differences in ... 27
Eldridge, G. H., cited on wells of Denver Basin ... 94, 95
Electrical method of determining rate of underflow, curve obtained by ... 49
  description of ... 48–51
  diagram illustrating ... 48
Failure of artesian wells, discussion of ... 93–95
Fans. *See* Deltas.
Faults, association of springs with ... 79
Flow, deep zones of, discussion of ... 52–60
    distinguishing features of ... 53–54
    percolation into ... 54–57
  diagrams illustrating ... 34, 35, 36
  filter for determining, figure showing ... 49
  formulas for determining ... 18–21, 24–30
  in open wells ... 62–68
  lines of, into well, plate showing ... 82
  rate of ... 26

Page.
Flow, variations in, due to change in pressure, diagram illustrating 28
due to temperature 24
velocity of, in sands of various effective sizes, table showing 27
See also Motion; Underflow; Surface flows.
Fresno canal, California, seepage on 42
Galleries and subcanals, use of, in obtaining water 73-76
See also Infiltration galleries.
Garden, Kans., underflow at, velocity of 43
well at, diagrams showing rise of water in 68
Gas, diagram illustrating retention of 56
Gerhardt, I. P., diagrams taken from article by 71, 72
Gilbert, G. K., cited on underflow in Arkansas River Valley 43
Grains of soil, effective size of, methods of determining 22-23
variation in velocity of flow based on difference in 27
Granite, porosity of 16
Great Falls, Mont., section near 58
Ground water, depth of 14
flow of, diagrams illustrating 34, 35, 36
motion of, direction of 34-38
map showing position of water table, thalwegs and 33
position of, section showing 13
surface zone of, flow of 31-51
See also Water table.
Grunsky, C. E., cited on seepage in California 42
Hazen, Allen, law of flow formulated by 19
method of determining effective size of soil grains devised by 22-23
Hicks, L. E., cited on underflow near Loup River 42
Hoadley, J. C., apparatus devised by, figure showing 66
experiments of 62
Hobbs, W. H., cited on association of springs and faults 79
Hurley, J. T., reference to 42
Impervious floor, spring at outcrop of, plate showing 62
springs along, formation of 61-62
Infiltration galleries, longitudinal section of 76
plan of 75
principle involved in construction of, diagram showing 74
Johnson, W. D., infiltration galleries designed by, diagrams showing 74, 76
work of 67
Johnston, T., reference to 100
King, F. H., method of determining effective size of soil grains devised by 23
work of 20
Land surface, area of 14
Latham, B., observations of 71
Laville, Wis., sandstone from, section of 20

Page.
Limestone, porosity of 16
Lower Magnesian limestone, porosity of 16
Lueger, O., cited 37, 72
Magnesian limestone. *See* Lower Magnesian limestone.
Marblehead, Wis., limestone from, porosity of 16
Missouri River, section along 58
Mohave River, underflow on 50
Montello, Wis., granite from, porosity of 16
Motion, cause and rate of 17-18
direction of 34
See also Flow.
Munich, fluctuations of water table at, diagram showing 71
Neighboring wells, nonuniformity of 69-70
Nettleton, E. S., cited on underflow of Rio Grande 40
Newell, F. H., letter of transmittal by 11
Niagara limestone, porosity of 16
Nonuniformity in neighboring wells, discussion of 69-70
Ocean water, amount of 15
Oil, diagram illustrating retention of 56
Open wells, flow of water in 62-68
Orton, E., cited on Trenton limestone 53
Quartz sand, porosity of 17
Pacoima Creek, Cal., subsurface dam on, description of 76-77
Pacoima Wash, views on, plate showing 74, 76, 78
Peale, A. C., cited on association of springs and faults 79
Percolation into deep zones, discussion of 54-57
Permeability of rocks and soils, discussion of 15-16
Pervious bed, seepage in, figures illustrating 37, 38
Porosities of soil, constants for 25
Porosity of rocks and soils, discussion of 16-17
Potsdam formation, map showing outcrop in Wisconsin 59
water in 59-60
Pressure, decrease in, diagram showing 83
diagram showing variations in maximum flow due to differences in 28
River valley, section, ideal, across 13
Rivers, contamination of wells from, diagram illustrating 73
Rockford, Ill., artesian wells at, flow of 96-97
Rocks, permeability of 15-16
porosity of soils and 16-17
Rogers, E. L., cited on flow in sands 26
St. Augustine, Fla., artesian wells at, flow of 96
St. Peter sandstone, map showing outcrop in Wisconsin 59
water in 60
Salbach, B., cited on underflow waters 40
Sand quartz, porosity of 17
Sands, velocity of water in 27
Sandstone, porosity of 16
sections of 20

Page.
Savannah, Ga., artesian wells at, flow of 96, 97–101
map showing location of 98
Seepage in pervious bed, figures illustrating 37, 38
Sink-hole, connection with underground-drainage system, plate showing 32
Slichter, C. S., formulas for determining flow of water devised by 24–28, 48–51
work of 20
Soil grains, effective size of, determination of, methods of 22–23
variations in velocity of flow based on differences in 27
Soils, mechanical analysis of 21–23
porosities of, constants for 25
porosity of rocks and 16–17
South Britain, Conn., springs near, map showing location of 80
South Dakota artesian basin, cross section through 55
Spheres, pore space in mass of, unit element of 21
pores in mass composed of, shape of 20
Spring at outcrop of impervious floor, plate showing 62
Springfield well, Savannah, Ga., flow of 99
Springs, association of, with faults 79
formation of, diagrams showing 61
water available for, conditions affecting amount of 73
Streams, disappearing, deltas or fans of, map showing 38
Subcanals and galleries, use of, in obtaining water 73–76
Subsurface dam on Pacoima Wash, views of 74, 76, 78
Subsurface dams, discussion of 76–77
Surface flows, recovery of underground water from 61–78
Surface wells, contamination of, from cesspools 68–69
diagram illustrating 69
See also Wells.
Temperature, effect on velocity and flow of water 24
Thalweg, definition of 32
Thalwegs, map showing position of water table, motion of ground water, and 33
Thiem, A., method of determining rate of underflow devised by 47
Tile drainage, effect of 46
Todd, J. E., method of measuring yield of wells devised by 90
Tubular and dug well, figure showing 67
Underflow, chlorine method of determining rate of, curve obtained by 47
description of 46–48
electrical method of determining rate of, curve obtained by 49
description of 48–51
diagram illustrating 48

Page.
Underflow, general considerations concerning 38–41
movement of, rate of 41–43
Underground channel, view of 32
Underground drainage basins, discussion of 32–33
Underground drainage system, sink-hole connection with, plate showing 32
Underground water, amount of 14–15
flow of, filter for determining 19
formulas for determining 18–21, 24–30
motion of, cause and rate of 17–18
origin and extent of 13–30
recovery of, from surface flows 61–78
See also Underground drainage; Underground channels; Water table; Ground water; Wells; Springs; Underflow.
Underground water supply, advantage of 77–78
Valley, ideal section across 13
Van Hise, C. R., cited on limit of depth of ground water 14
cited on work of underground water 17
reference to 15
Velocity of flow. *See* Flow.
Victorville, Cal., underflow near 50
Viscosity of water, variation in, with temperature 24
Water, velocity of, in sands 27
viscosity of, variation in, with temperature 24
Water, ground, depth of 14
flow of, diagrams illustrating 34, 35, 36
motion of, direction of 34–38
map showing position of water table, thalwegs and 33
position of, section showing 13
surface zone of flow of 31–51
See also Water table; Water, underground.
Water, underground, amount of 14–15
flow of, filter for determining 19
formulas for determining 18–21, 24–30
motion of, cause and rate of 17–18
origin and extent of 13–30
recovery of, from surface flows 61–78
See also Underground drainage; Underground channels; Ground water; Water table; Wells; Springs; Underflow.
Water surface, area of 14
Water plane. *See* Water table.
Water table, definition and depth of 13
effect of pumping on, diagrams showing 64, 65
irregularities in, diagram showing 70
position of, fluctuation in 70–73
map showing thalweg, motion of ground water, and 33
shape of 33–38
near drainage ditch 29
undulations of, section showing 13
See also Ground water.

Page.
Wauwatosa, Wis., limestone from, porosity of 16
Well at Garden, Kans., diagrams showing rise of water in 68
Well, artesian, view of 62
lines of flow into, plate showing 82
Well, combination dug and tubular, figures showing 67
Well, common dug, figures showing 63
Wells, contamination of, from cesspools, diagram showing 69
from cesspools, discussion of 68-69
from rivers, diagram illustrating 73
nonuniformity in neighboring 69-70
water available for, conditions affecting amount of 73
Wells, artesian, at Savannah, Ga., yield of 96, 97-101
Wells, artesian, conditions necessary to 82
failure of 93-95
general discussion of 79-83
mutual interference of 95-97
yield of 83-90
method of measuring 90-93
Wells, common open, flow of water in 62-68
Wells, surface, contamination of 68-69
diagram illustrating 69
Weston, E. B., reference to 84
Wisconsin, building stones from, porosities of 16
Potsdam and St. Peter sandstones in, map of 59
sandstone from, sections of 20

O

1895.

Sixteenth Annual Report of the United States Geological Survey, 1894–95, Part II, Papers of an economic character, 1895; octavo, 598 pp.

Contains a paper on the public lands and their water supply, by F. H. Newell, illustrated by a large map showing the relative extent and location of the vacant public lands; also a report on the water resources of a portion of the Great Plains, by Robert Hay.

A geological reconnoissance of northwestern Wyoming, by George H. Eldridge, 1894; octavo, 72 pp, Bulletin No. 119 of the United States Geological Survey.

Contains a description of the geologic structure of portions of the Big Horn Range and Big Horn Basin, especially with reference to the coal fields, and remarks upon the water supply and agricultural possibilities.

Report of progress of the division of hydrography for the calendar years 1893 and 1894, by F. H. Newell, 1895; octavo, 126 pp. Bulletin No. 131 of the United States Geological Survey.

Contains results of stream measurements at various points, mainly within the arid region, and records of wells in western Nebraska, western Kansas, and eastern Colorado.

1896.

Seventeenth Annual Report of the United States Geological Survey, 1895–96, Part II, Economic geology and hydrography, 1896; octavo, 864 pp.

Contains papers on "The underground water of the Arkansas Valley in eastern Colorado," by G. K. Gilbert; "The water resources of Illinois," by Frank Leverett; and "Preliminary report on the artesian waters of a portion of the Dakotas," by N. H. Darton.

Artesian-well prospects in the Atlantic Coastal Plain region, by N. H. Darton, 1896; octavo, 232 pp., 19 plates. Bulletin No. 138 of the United States Geological Survey.

Gives a description of the geologic conditions of the coastal region from Long Island, N. Y., to Georgia, and contains data relating to many of the deep wells.

Report of progress of the division of hydrography for the calendar year 1895, by F. H. Newell, hydrographer in charge, 1896; octavo, 356 pp. Bulletin No. 140 of the United States Geological Survey.

Contains a description of the instruments and methods employed in measuring streams and the results of hydrographic investigations in various parts of the United States.

1897.

Eighteenth Annual Report of the United States Geological Survey, 1896–97, Part IV, Hydrography, 1897; octavo, 756 pp.

Contains a "Report of progress of stream measurements for the calendar year 1896," by Arthur P. Davis; "The water resources of Indiana and Ohio," by Frank Leverett; "New developments in well boring and irrigation in eastern South Dakota," by N. H. Darton; and "Reservoirs for irrigation," by J. D. Schuyler.

1899.

Nineteenth Annual Report of the United States Geological Survey, 1897–98, Part IV, Hydrography, 1899; octavo, 814 pp.

Contains a "Report of progress of stream measurements for the calendar year 1897," by F. H. Newell and others; "The rock waters of Ohio," by Edward Orton; and "A preliminary report on the geology and water resources of Nebraska west of the one hundred and third meridian," by N. H. Darton.

Part II of the Nineteenth Annual contains a paper on "Principles and conditions of the movements of ground water," by F. H. King, and one on "Theoretical investigation of the motion of ground waters," by C. S. Slichter.

1900.

Twentieth Annual Report of the United States Geological Survey, 1898–99, Part IV, Hydrography, 1900; octavo, 660 pp.

Contains a "Report on progress of stream measurements for the calendar year 1898," by F. H. Newell, and "Hydrography of Nicaragua," by A. P. Davis.

1901.

Twenty-first Annual Report of the United States Geological Survey, 1899–1900, Part IV, Hydrography, 1901; octavo, 768 pp.

Contains a "Report of progress of stream measurements for the calendar year 1899," by F. H. Newell; "Preliminary description of the geology and water resources of the southern half of the Black Hills and adjoining regions in South Dakota and Wyoming," by N. H. Darton; and "The high plains and their utilization," by W. D. Johnson.

Such of the above papers as are published by the United States Geological Survey may be obtained on application until the edition is exhausted. Correspondence should be addressed to

The Director, United States Geological Survey,
Washington, D. C.

WATER-SUPPLY AND IRRIGATION PAPERS.

1. Pumping water for irrigation, by Herbert M. Wilson, 1896.
2. Irrigation near Phoenix, Ariz., by Arthur P. Davis, 1897.
3. Sewage irrigation, by George W. Rafter, 1897.
4. A reconnoissance in southeastern Washington, by Israel C. Russell, 1897.
5. Irrigation practice on the Great Plains, by E. B. Cowgill, 1897.
6. Underground waters of southwestern Kansas, by Erasmus Haworth, 1897.
7. Seepage waters of northern Utah, by Samuel Fortier, 1897.
8. Windmills for irrigation, by E. C. Murphy, 1897.
9. Irrigation near Greeley, Colo., by David Boyd, 1897.
10. Irrigation in Mesilla Valley, New Mexico, by F. C. Barker, 1898.
11. River heights for 1896, by Arthur P. Davis, 1897.
12. Water resources of southeastern Nebraska, by Nelson Horatio Darton, 1898.
13. Irrigation systems in Texas, by William Ferguson Hutson, 1898.
14. New tests of pumps and water lifts used in irrigation, by O. P. Hood, 1898.
15, 16. Operations at river stations, 1897, Parts I, II, 1898.
17. Irrigation near Bakersfield, Cal., by C. E. Grunsky, 1898.
18. Irrigation near Fresno, Cal., by C. E. Grunsky, 1898.
19. Irrigation near Merced, Cal., by C. E. Grunsky, 1899.
20. Experiments with windmills, by Thomas O. Perry, 1899.
21. Wells of northern Indiana, by Frank Leverett, 1899.
22. Sewage irrigation, Part II, by George W. Rafter, 1899.
23. Water-right problems of the Bighorn Mountains, by Elwood Mead, 1899.
24, 25. Water resources of the State of New York, Parts I, II, by G. W. Rafter, 1899.
26. Wells of southern Indiana (continuation of No. 21), by Frank Leverett, 1899.
27, 28. Operations at river stations, 1898, Parts I, II, 1899.
29. Wells and windmills in Nebraska, by Erwin Hinckley Barbour, 1899.
30. Water resources of the Lower Peninsula of Michigan, by Alfred C. Lane, 1899.
31. Lower Michigan mineral waters, by Alfred C. Lane, 1899.
32. Water resources of Porto Rico, by H. M. Wilson, 1900.
33. Storage of water on Gila River, Arizona, by J. B. Lippincott, 1900.
34. Underground waters of a portion of southeastern S. Dak., by J. E. Todd, 1900.
35–39. Operations at river stations, 1899, Parts I–V, 1900.
40. The Austin dam, by Thomas U. Taylor, 1900.
41, 42. The windmill: its efficiency and use, Parts I, II, by E. C. Murphy, 1901.
43. Conveyance of water in irrigation canals, etc., by Samuel Fortier, 1901.
44. Profiles of rivers, by Henry Gannett, 1901.
45. Water storage on Cache Creek, California, by Albert E. Chandler, 1901.
46. Reconn. of Kern and Yuba rivers, Cal., by F. H. Olmsted and M. Manson, 1901.
47–52. Operations at river stations, 1900, Parts I–VI, 1901.
53, 54. Geology and water resources Nez Perce Co., Idaho, Pts. I, II, by I. C. Russell.
55. Geology and water resources of Yakima Co., Wash., by G. O. Smith, 1901.
56. Methods of stream measurement, 1901.
57. Deep borings in United States, Part I, by N. H. Darton, 1902.
58. Water storage on Kings River, California, by J. B. Lippincott, 1902.
59, 60. Development and application of water in southern California, Parts I, II, by J. B. Lippincott, 1902.
61. Deep borings in United States, Part II, by N. H. Darton, 1902.
62, 63. Hydrography of the Southern Appalachian region, Parts I, II, by H. A. Pressey, 1902.
64. Accuracy of stream measurements, by E. C. Murphy, 1902.
65, 66. Operations at river stations, 1901, Parts I, II, 1902.
67. The motions of underground waters, by C. S. Slichter, 1902.

Other papers are in preparation. These pamphlets will be sent to persons who have assisted in their preparation through replies to schedules or otherwise. Requests for a certain paper are granted whenever practicable, but it is impossible to comply with general demands, such as to have all the series sent. Application should be made either to members of Congress or to

The Director, United States Geological Survey,
Washington, D. C.

19.13/68
CLEMSON COLLEGE LIBRARY
GOVERNMENT PUBLICATIONS

DEPARTMENT OF THE INTERIOR

WATER-SUPPLY

AND

IRRIGATION PAPERS

OF THE

UNITED STATES GEOLOGICAL SURVEY

No. 68

WATER STORAGE IN THE TRUCKEE BASIN, CALIFORNIA-NEVADA.—TAYLOR

WASHINGTON
GOVERNMENT PRINTING OFFICE
1902

IRRIGATION REPORTS.

The following list contains titles and brief descriptions of the principal reports relating to water supply and irrigation prepared by the United States Geological Survey since 1890:

1890.

First Annual Report of the United States Irrigation Survey, 1890; octavo, 123 pp.

Printed as Part II, Irrigation, of the Tenth Annual Report of the United States Geological Survey, 1888–89. Contains a statement of the origin of the Irrigation Survey, a preliminary report on the organization and prosecution of the survey of the arid lands for purposes of irrigation, and report of work done during 1890.

1891.

Second Annual Report of the United States Irrigation Survey, 1891; octavo, 395 pp.

Published as Part II, Irrigation, of the Eleventh Annual Report of the United States Geological Survey, 1889–90. Contains a description of the hydrography of the arid region and of the engineering operations carried on by the Irrigation Survey during 1890; also the statement of the Director of the Survey to the House Committee on Irrigation, and other papers, including a bibliography of irrigation literature. Illustrated by 30 plates and 4 figures.

Third Annual Report of the United States Irrigation Survey, 1891; octavo, 576 pp.

Printed as Part II of the Twelfth Annual Report of the United States Geological Survey, 1890–91. Contains "Report upon the location and survey of reservoir sites during the fiscal year ended June 30, 1891," by A. H. Thompson; "Hydrography of the arid regions," by F. H. Newell; "Irrigation in India," by Herbert M. Wilson. Illustrated by 93 plates and 190 figures.

Bulletins of the Eleventh Census of the United States upon irrigation, prepared by F. H. Newell; quarto.

No. 35, Irrigation in Arizona; No. 60, Irrigation in New Mexico; No. 85, Irrigation in Utah; No. 107, Irrigation in Wyoming; No. 153, Irrigation in Montana; No. 157, Irrigation in Idaho; No. 163, Irrigation in Nevada; No. 178, Irrigation in Oregon; No. 193, Artesian wells for irrigation; No. 198, Irrigation in Washington.

1892.

Irrigation of western United States, by F. H. Newell; extra census bulletin No. 23, September 9, 1892; quarto, 22 pp.

Contains tabulations showing the total number, average size, etc., of irrigated holdings, the total area and average size of irrigated farms in the subhumid regions, the percentage of number of farms irrigated, character of crops, value of irrigated lands, the average cost of irrigation, the investment and profits, together with a résumé of the water supply and a description of irrigation by artesian wells. Illustrated by colored maps showing the location and relative extent of the irrigated areas.

1893.

Thirteenth Annual Report of the United States Geological Survey, 1891–92, Part III, Irrigation, 1893; octavo, 486 pp.

Consists of three papers: "Water supply for irrigation," by F. H. Newell; "American irrigation engineering," and "Engineering results of the Irrigation Survey," by Herbert M. Wilson; and "Construction of topographic maps and selection and survey of reservoir sites," by A. H. Thompson. Illustrated by 77 plates and 119 figures.

A geological reconnoissance in central Washington, by Israel Cook Russell, 1893; octavo, 108 pp., 12 plates. Bulletin No. 108 of the United States Geological Survey.

Contains a description of the geologic structure in and adjacent to the drainage basin of Yakima River and the great plains of the Columbia to the east of this area, with special reference to the occurrence of artesian waters.

1894.

Report on agriculture by irrigation in the western part of the United States at the Eleventh Census, 1890, by F. H. Newell, 1894; quarto, 283 pp.

Consists of a general description of the condition of irrigation in the United States, the area irrigated, cost of works, their value and profits; also describes the water supply, the value of water, of artesian wells, reservoirs, and other details; then takes up each State and Territory in order, giving a general description of the condition of agriculture by irrigation, and discusses the physical conditions and local peculiarities in each county.

Fourteenth Annual Report of the United States Geological Survey, 1892–93; Part II, Accompanying papers, 1894; octavo, 597 pp.

Contains papers on "Potable waters of the eastern United States," by W J McGee; "Natural mineral waters of the United States," by A. C. Peale; and "Results of stream measurements," by F. H. Newell. Illustrated by maps and diagrams.

(Continued on third page of cover.)

DEPARTMENT OF THE INTERIOR

WATER-SUPPLY

AND

IRRIGATION PAPERS

OF THE

UNITED STATES GEOLOGICAL SURVEY

No. 68

WASHINGTON
GOVERNMENT PRINTING OFFICE
1902

UNITED STATES GEOLOGICAL SURVEY

CHARLES D. WALCOTT, DIRECTOR

WATER STORAGE

IN THE

TRUCKEE BASIN, CALIFORNIA-NEVADA

BY

L. H. TAYLOR

WASHINGTON

GOVERNMENT PRINTING OFFICE

1902

CONTENTS.

	Page.
Letter of transmittal	7
Location of basin	9
Precipitation	10
Drainage areas	15
Run-off and stream flow	16
Evaporation	34
Investigations of 1889 and 1890	36
Reservoir sites	36
Canal routes	38
Investigations of 1900–1901	39
Reservoir sites	39
Impracticable sites	40
Lake Tahoe	43
Donner Lake	51
Independence Lake	56
Twin Valley	59
Little Truckee	61
Henness Pass Valley	66
Dog Valley	69
Present uses of water and existing water rights	72
Power	72
Irrigation	74
Summary	77
Irrigable lands	77
Ownership of lands	78
Duty of water	79
Quantity of water required and available	80
Proposed distribution canals	81
Truckee River Highline canal	81
Branch canals	82
Lower Truckee canal	83
Possible uses of water for power development	84
Necessity for national control of water	85
General conclusions and recommendations	86
Financial summary	87
Index	89

ILLUSTRATIONS.

		Page.
PLATE I.	Portion of Lake Tahoe	10
II.	*A*, Truckee River at Stateline Mills, Cal.; *B*, Truckee River at Vista, Nev., gaging station	18
III.	Truckee River at Reno, Nev., during low water in July, 1900	32
IV.	*A*, Dam in Truckee River at Lake Tahoe; *B*, View looking eastward from head of Emerald Bay, Lake Tahoe	42
V.	*A*, Donner Lake; *B*, Falls of Little Truckee River a half mile below Webber Lake	50
VI.	*A*, Dam of Floriston Pulp and Paper Company in Truckee River; *B*, Truckee River Canyon, looking downstream from Floriston Pulp and Paper Company's dam	72
VII.	*A*, Flume of Truckee River General Electric Company on side hill above Mystic, Cal.; *B*, Headworks of flume of Truckee River General Electric Company at Floriston, Cal	74
VIII.	*A*, Power house of Truckee River General Electric Company at Mystic, Cal.; *B*, Interior of power house of Truckee River General Electric Company	76
FIG. 1.	Map of the Truckee Basin, showing minor drainage basins and location of rainfall stations	9
2.	Contour map of Webber Lake and profile of dam site	41
3.	Map of Squaw Valley reservoir site	42
4.	Contour map of Squaw Valley dam site	42
5.	Map of Lake Tahoe	44
6.	Contour map of Lake Tahoe dam site	48
7.	Contour map of Donner Lake reservoir site	52
8.	Profile of Donner Lake dam site	54
9.	Contour map of Independence Lake reservoir site	56
10.	Profile of Independence Lake dam site	57
11.	Contour maps of Twin Valley reservoir and dam sites	59
12.	Contour map of Little Truckee reservoir site No. 1	61
13.	Contour map of dam site of Little Truckee reservoir No. 1	62
14.	Map of Boca reservoir site	64
15.	Map of Henness Pass Valley reservoir site and supply canal	67
16.	Contour map of Henness Pass Valley dam site	68
17.	Contour map of Dog Valley reservoir site	69
18.	Profile of Dog Valley dam site	70
19.	Map showing location of irrigation canals in western portion of the Truckee Basin	74
20.	Map showing location of irrigation canals in eastern portion of the Truckee Basin	75

LETTER OF TRANSMITTAL.

DEPARTMENT OF THE INTERIOR,
UNITED STATES GEOLOGICAL SURVEY,
DIVISION OF HYDROGRAPHY,
Washington, D. C., April 15, 1902.

SIR: I have the honor to transmit herewith a paper prepared by Mr. L. H. Taylor, entitled Water Storage in the Truckee Basin, California-Nevada, and to request that it be published in the series of Water-Supply and Irrigation Papers. It relates to surveys and examinations made by Mr. Taylor, as resident hydrographer of this Survey, and in cooperation with the State of Nevada, in order to ascertain the extent to which the waters of Truckee River can be conserved and utilized in the development of the arid lands of that State. Mr. Taylor shows that by constructing various dams and other hydraulic works a large amount of water which now runs to waste can be saved and conducted out upon vacant public land, furnishing a supply also to some of the lands now in private ownership. This is one of the most important of the interstate irrigation problems which have been carefully examined. The construction of the works described by Mr. Taylor would do much toward increasing the cultivated area and the population of Nevada, and would cause the State to rise rapidly in agricultural rank.

Very respectfully,

F. H. NEWELL,
Hydrographer in Charge.

Hon. CHARLES D. WALCOTT,
Director United States Geological Survey.

WATER STORAGE IN THE TRUCKEE BASIN, CALIFORNIA-NEVADA.

By L. H. Taylor.

LOCATION OF BASIN.

The region drained by Truckee River is embraced between meridians 119° 10′ and 120° 28′ west longitude and parallels 38° 42′ and

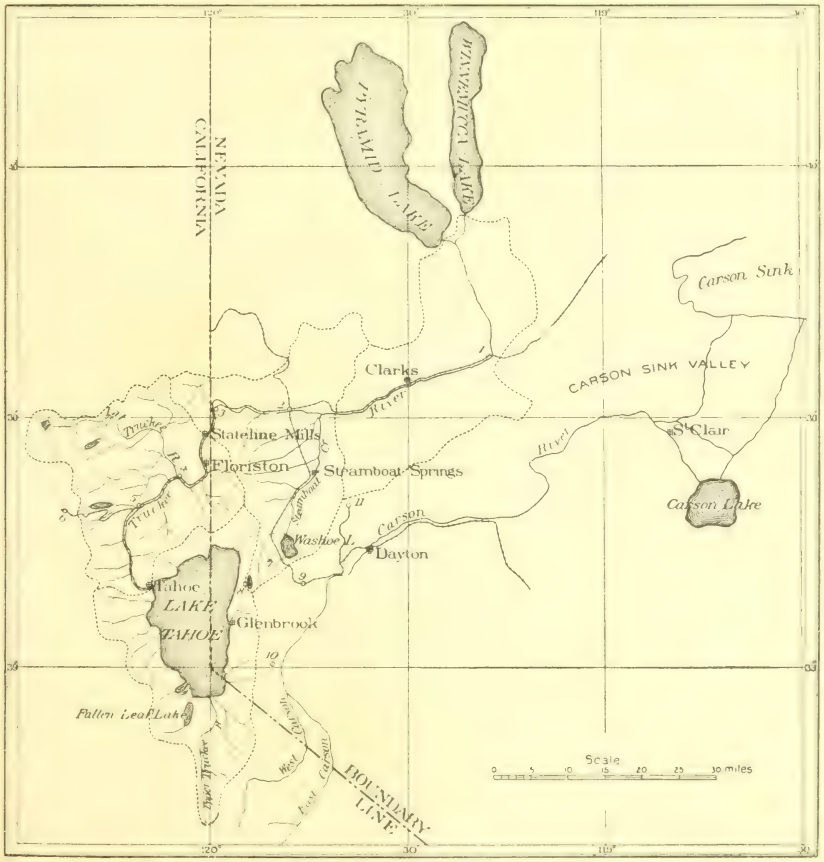


Fig. 1.—Map of the Truckee Basin, showing minor drainage basins and location of rainfall stations.

Rainfall stations:

1. Wadsworth.	4. Boca.	7. Lewers's ranch.	10. Genoa.
2. Reno.	5. Truckee.	8. Marlette Lake.	11. Virginia.
3. Verdi.	6. Summit.	9. Carson.	

40° 20′ north latitude, being partly in the State of California and partly in Nevada. (See map of Truckee Basin, fig. 1.) The upper

or western portion of the basin lies immediately east of the summit of the main Sierra Nevada, and embraces a high, forest-clad region ranging in altitude from 5,000 to 11,000 feet above sea level, on which the precipitation, which is mainly in the form of snow, is heavy. The greater part of the area is in the State of California. The eastern or lower part of the basin, which is entirely within the State of Nevada, is essentially different in character, being made up of broad, open valleys and barren hills, distinctly typical of the Great Basin.

The river flows northward and enters Lake Tahoe at an elevation of 6,225 feet above sea level. This lake is the largest body of fresh water at that altitude in the United States, its area being 193 square miles. (A portion of the lake is shown in Pl. I; see also fig. 5, p. 44.) As the boundary line between Nevada and California passes through the lake, a portion of it is in each State. The outlet of the lake is at Tahoe, Cal. After leaving the lake the river has a general northward course until it reaches Verdi, Nev., a short distance from the State line, and about 40 miles from the lake. In this part of its course it receives a number of important tributaries which augment its flow. There are a number of lakes at the headwaters of the branch streams. After passing Verdi the river, entering what has been called the lower portion of the Truckee Basin, flows eastward a distance of 45 miles, passing through the Reno Valley and the Lower Truckee Canyon to Wadsworth, whence it turns northward, flows about 20 miles farther, and discharges into Pyramid and Winnemucca lakes.

PRECIPITATION.

Precipitation records have been kept at eight places within the basin of Truckee River, and at three stations—Virginia, Carson, and Genoa—immediately adjacent to the south and east, as shown in fig. 1. At a majority of these stations, in fact at all except Reno and Lewers's ranch, in the Truckee Basin, the observations were made by the agents and telegraph operators of the Southern Pacific Railroad Company. The records afford the only data available, and probably furnish means approximating the truth.

The following table gives the annual precipitation at all of the stations referred to except Marlette Lake, where observations were made during only twelve months, from July 1, 1894, to June 30, 1895:

PORTION OF LAKE TAHOE.

Annual rainfall, in inches, at ten stations on eastern slope of Sierra Nevada in and adjacent to basin of Truckee River.

Year.	Wadsworth (4,077).a	Reno (4,497).a	Verdi (4,895).a	Boca (5,541).a	Truckee (5,819).a	Summit (7,017).a	Lewers's ranch (5,177).a	Genoa (4,824).a	Carson (4,670).a	Virginia (6,242).a
1870	2.30	.....	.....	13.46	23.28	34.29	.....	.....	.....	
1871	4.04	4.86	.....	16.87	36.71	60.60	.....	.....	.....	
1872	0.70	4.11	.....	8.40	27.29	37.90	.....	.....	.....	.....
1873	1.84	2.75	.....	11.65	26.16	40.95	.....	.....	.....	.....
1874	4.13	5.70	.....	21.85	35.69	18.85	.....	.....	.....	
1875	3.96	6.06	.....	10.66	27.50	33.86	.....	.....	17.73	.....
1876	2.27	3.59	.....	17.73	28.85	46.90	.....	.....	9.06	
1877	4.27	5.68	.....	8.89	16.13	26.73	.....	.....	.....	
1878	4.85	6.32	.....	15.81	25.81	32.69	.....	.....	.....	
1879	3.88	4.02	.....	21.08	27.86	73.67	.....	.....	.....	
1880	3.31	6.70	.....	16.79	37.61	64.50	.....	.....	13.10	.....
1881	5.01	5.89	.....	2.42	21.28	30.95	.....	.....	10.33	
1882	3.56	5.48	.....	21.00	30.50	62.12	.....	.....	11.29	
1883	2.82	3.95	.....	11.30	16.80	23.57	.....	.....	6.95	.....
1884	4.79	6.17	.....	28.60	43.81	60.47	.....	.....	17.82	.....
1885	3.59	2.95	.....	8.38	14.91	25.41	.....	.....	11.32	.....
1886	5.30	4.82	.....	17.60	18.55	41.00	.....	.....	10.93	.....
1887	6.70	5.78	.....	20.39	25.95	49.97	.....	.....	8.54	
1888	3.78	4.60	.....	11.23	8.85	38.02	.....	.....	7.12	.....
1889	5.19	6.43	17.87	38.40	19.16	51.42	.....	22.80	12.44	.....
1890	6.78	9.72	15.63	32.07	39.45	58.83	.....	16.89	13.80	
1891	6.22	10.45	.....	28.10	26.85	26.03	29.00	22.61	18.30	20.41
1892	4.65	11.92	18.33	29.05	31.10	44.70	26.29	.....	14.25	15.91
1893	.....	4.74	.....	27.62	32.54	.....	22.66	15.78	11.42	14.79
1894	.....	7.27	.....	27.64	30.45	.....	25.69	12.50	12.78	19.78
1895	4.51	5.53	20.97	16.47	23.39	.....	20.36	10.45	10.91	.....
1896	10.28	10.59	23.09	30.50	29.61	.....	30.50	.....	14.64	.....
1897	7.25	8.00	13.13	26.02	27.33	.....	25.61	.....	13.62	.....
1898	4.27	6.41	3.91	14.81	12.21	31.46	14.32	.....	6.04	.....
1899	5.32	8.50	18.06	32.47	33.86	73.80	26.35	.....	9.78	.....
1900	5.30	7.81	8.97	25.29	17.56	42.52	23.72	.....	10.13	.....

a Elevation above sea level, in feet.

For the purpose of showing the distribution of rainfall throughout the year the following tables of the monthly precipitation during the last thirteen years at the eleven stations mentioned have been prepared. The tables have been arranged for the twelve months beginning September 1 and ending August 31 of the following year, as the latter date is near the end of the irrigating season and is the time when the streams reach their lowest stage.

Monthly precipitation, in inches, at Wadsworth, Nev.

[Elevation, 4,077 feet.]

Season.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Total.
1888-89	.....	.....	.....	.....	.....	.....	.....	.....	0.29	0.24	0.00	0.00	.....
1889-90	0.00	0.29	0.55	1.16	1.95	0.70	0.28	0.04	1.10	0.00	0.00	0.00	6.07
1890-91	1.55	0.50	0.05	0.61	.....	.....	.....	.....	.....	.....	.....	.....	.....
1894-95	*a* 0.35	*a* 0.39	*a* 0.57	*a* 0.62	0.75	0.55	0.20	0.20	1.06	0.00	0.05	0.05	*b* 4.79
1895-96	0.05	0.05	0.45	0.10	3.22	0.00	0.22	0.35	0.64	0.00	2.04	1.20	8.30
1896-97	0.41	0.10	2.05	0.05	0.89	2.33	0.23	0.00	0.30	0.20	0.00	0.00	6.56
1897-98	0.25	1.78	0.29	0.98	0.83	0.05	0.60	0.30	1.37	0.00	0.00	0.05	6.50
1898-99	0.18	0.22	0.58	0.09	*a* 1.21	0.30	0.70	0.10	0.42	*a* 0.07	0.10	0.05	*b* 4.02
1899-1900	0.00	0.20	0.10	1.95	0.35	0.25	0.64	1.92	1.12	0.05	0.08	0.00	6.66
1900-1901	0.34	T.	0.50	0.05	0.51	1.18	*a* 0.41	0.30	0.76	0.10	0.00	1.92	6.07
Mean	0.35	0.39	0.57	0.62	1.21	0.67	0.41	0.40	0.77	0.07	0.25	0.36	6.07

a Normal rainfall: record for month is missing.
b Includes the months for which rainfall has been estimated.
T. indicates trace.
Records for missing years are not obtainable.

Monthly precipitation, in inches, at Reno, Nev.

[Elevation, 4,497 feet.]

Season.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Total.
1888–89	0.00	0.00	0.99	0.43	0.30	0.25	0.95	0.00	0.17	0.00	0.00	0.00	3.09
1889–90	0.00	0.75	1.10	2.91	4.20	1.75	0.80	0.16	0.31	0.00	0.00	0.16	12.14
1890–91	0.90	0.00	0.00	1.30	0.06	2.69	0.28	0.56	2.72	0.41	*a* 0.15	*a* 0.38	*b* 11.45
1891–92	0.54	*a* 0.31	0.05	1.14	0.58	1.40	0.76	0.09	0.22	1.27	0.00	0.00	*b* 6.36
1892–93	0.07	0.27	4.65	2.61	1.51	1.10	0.58	0.38	0.13	0.00	0.00	0.04	11.34
1893–94	0.24	0.02	0.42	0.32	0.89	1.42	0.22	0.10	0.91	1.06	0.31	0.11	6.02
1894–95	0.19	0.16	0.02	1.88	2.81	0.33	0.07	0.39	0.57	0.00	0.00	0.02	6.44
1895–96	0.24	0.10	0.17	0.83	2.87	0.00	1.15	1.31	1.23	0.00	1.03	0.79	9.71
1896–97	0.93	0.08	0.89	0.31	1.05	2.10	0.72	0.03	1.73	0.20	0.00	0.07	8.11
1897–98	0.02	0.96	0.16	0.87	0.99	1.47	0.65	0.41	0.95	0.00	0.00	0.16	6.64
1898–99	0.31	0.24	0.63	0.60	*a* 1.52	0.65	1.03	0.12	0.41	0.40	0.22	1.37	*b* 7.49
1899–1900	T.	0.72	0.47	1.69	0.50	0.27	0.59	1.75	0.39	1.08	0.18	*a* 0.38	*b* 8.02
1900–1901	0.67	0.44	1.48	0.46	2.48	3.24	0.39	0.32	1.60	T.	T.	1.60	12.68
Mean	0.32	0.31	0.85	1.18	1.52	1.28	0.78	0.43	0.87	0.34	0.15	0.38	8.41

a Normal rainfall; record for month is missing.
b Includes the months for which rainfall has been estimated.
T. indicates trace.

Monthly precipitation, in inches, at Verdi, Nev.

[Elevation, 4,895 feet.]

Season.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Total.
1888–89					0.05	0.40	2.98	0.14	3.30	0.01	0.00	0.00	
1889–90	0.00	1.53	3.43	6.03	9.11	1.74	2.00	0.00	*a* 1.25	*a* 0.24	0.00	0.10	*b* 26.43
1890–91	0.00	0.72	T.	0.33									
1894–95					10.06	2.20	0.73	1.06	1.10	0.55	0.00	0.07	
1895–96	1.97	0.00	0.76	2.47	9.40	0.08	2.18	2.46	2.29	0.00	1.11	0.74	23.46
1896–97	1.00	0.18	2.05	1.60	1.35	4.99	2.75	0.00	0.40	0.20	0.00	0.20	14.72
1897–98	0.00	0.45	1.62	1.17	0.50	0.91	0.24	0.10	0.91	0.35	0.00	0.10	6.35
1898–99	0.19	0.05	0.20	0.36	*a* 4.29	0.55	4.60	0.50	1.09	0.03	*a* 0.16	1.60	*b* 13.62
1899–1900	0.00	2.10	0.90	2.05	0.74	0.30	1.35	0.20	0.41	0.75	0.19	0.22	9.21
1900–1901	0.00	1.10	2.75	1.15	3.10	5.40	0.60	0.60	0.50	T.	0.00	0.50	15.70
Mean	0.40	0.77	1.46	1.90	4.29	1.84	1.94	0.56	1.25	0.24	0.16	0.39	15.20

a Normal rainfall; record for month is missing.
b Includes the months for which rainfall has been estimated.
T. indicates trace.
Records for missing years are not obtainable.

Monthly precipitation, in inches, at Boca, Cal.

[Elevation, 5,541 feet.]

Season.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Total.
1888–89	0.12	0.00	0.95	1.45	4.25	3.10	1.15	0.10	3.90	0.00	0.00	0.00	15.02
1889–90	0.00	1.50	4.55	19.85	14.60	5.40	5.45	1.28	0.70	0.00	0.00	0.00	53.33
1890–91	0.00	0.70	0.00	3.65	1.25	11.80	2.50	1.70	1.40	0.25	0.05	0.00	23.30
1891–92	0.60	0.00	0.25	8.30	0.70	3.35	1.70	2.70	3.10	0.70	0.00	0.00	21.40
1892–93	0.00	1.50	8.35	6.95	4.55	8.90	4.00	1.90	1.35	0.00	0.00	0.05	37.55
1893–94	0.55	0.25	2.42	3.70	5.10	7.55	0.75	1.00	0.33	T.	0.00	T.	21.65
1894–95	T.	0.61	0.51	11.80	8.36	1.20	0.45	0.70	0.90	T.	0.00	T.	24.53
1895–96	0.97	0.11	0.71	3.07	7.75	0.50	6.30	6.65	3.10	0.25	1.15	0.18	30.44
1896–97	0.35	0.00	2.47	1.80	2.20	6.35	8.35	0.10	0.50	0.40	0.00	0.50	23.02
1897–98	T.	2.10	2.80	2.72	1.55	2.90	2.50	1.30	0.85	1.00	0.00	0.00	17.42
1898–99	0.01	1.28	1.84	1.58	6.80	1.85	7.95	0.85	2.40	0.10	0.00	0.98	27.64
1899–1900	0.00	4.42	2.59	4.53	1.57	0.60	3.52	0.60	1.10	2.67	T.	1.22	22.82
1900–1901	0.66	3.04	5.73	4.58	7.17	6.76	2.24	2.04	1.86	0.00	0.00	0.08	34.16
Mean	0.25	1.19	2.55	5.69	5.07	4.64	3.60	1.61	1.65	0.41	0.09	0.23	26.98

T. indicates trace.

Monthly precipitation, in inches, at Truckee, Cal.

[Elevation, 5,819 feet.]

Season.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Total.
1888–89	0.12	0.00	2.38	1.58	0.80	1.40	2.51	1.01	4.51	0.00	0.00	0.00	14.31
1889–90	0.00	3.13	3.29	2.51	16.20	8.90	7.29	0.20	1.44	0.00	0.00	0.22	43.18
1890–91	0.80	0.45	0.00	3.70	1.22	8.36	3.92	2.17	2.90	0.46	0.00	0.00	23.98
1891–92	0.98	0.05	0.45	6.34	2.65	2.80	3.00	2.96	4.20	0.95	0.00	0.00	24.38
1892–93	0.29	0.37	5.73	8.15	5.44	8.02	5.18	3.73	1.79	0.00	0.00	0.00	38.70
1893–94	1.22	0.38	3.96	2.82	8.06	0.73	2.65	2.15	1.05	T.	*a* 0.01	0.00	*b* 23.03
1894–95	0.13	1.12	0.60	13.95	11.73	1.92	1.72	0.50	2.40	0.00	0.00	0.00	34.07
1895–96	1.32	0.34	0.50	2.96	7.07	0.40	4.67	9.36	0.54	0.00	0.15	0.34	27.65
1896–97	0.32	0.40	3.86	2.50	2.35	7.97	9.50	0.30	T.	0.18	0.00	*a* 0.11	*b* 27.19
1897–98	T.	0.55	3.20	3.15	1.05	3.65	2.05	0.25	0.30	0.00	0.00	0.00	14.20
1898–99	0.40	0.06	2.95	1.50	7.80	2.70	9.50	1.10	0.75	0.00	0.00	0.92	27.68
1899–1900	0.00	6.49	2.80	1.80	2.63	0.80	4.20	1.90	0.80	1.01	0.00	0.00	22.43
1900–1901	0.00	1.02	2.50	2.70	5.00	7.97	2.50	1.80	0.70	0.00	0.00	0.00	24.19
Mean	0.43	1.10	2.48	4.14	3.54	4.20	4.36	2.11	1.64	0.20	0.01	0.11	24.42

a Normal rainfall; record for month is missing.
b Includes the months for which rainfall has been estimated.
T. indicates trace.

Monthly precipitation, in inches, at Summit, Cal.

[Elevation, 7,017 feet.]

Season.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Total.
1888–89	0.00	0.00	3.37	5.26	1.00	1.50	9.55	1.90	6.30	0.22	0.00	0.00	29.10
1889–90	0.00	5.65	6.80	18.50	19.20	11.60	14.00	0.00	*a* 3.60	0.00	0.00	0.00	*b* 79.35
1890–91	0.00	0.00	0.00	7.40	1.50	1.38	5.10	4.60	1.10	0.00	0.00	0.00	21.08
1891–92	0.10	0.05	0.30	11.90	4.00	3.40	7.40	4.50	6.30	0.20	0.00	0.00	38.15
1892–93	0.00	1.18	3.53	7.06	7.90	*a* 6.14	14.50	9.20	*a* 3.60	0.00	*a* 0.04	0.00	*b* 53.17
1893–94	.....	0.30	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1897–98	.....	.....	.....	.....	4.00	7.10	5.20	0.80	2.90	0.90	0.04	0.00	.....
1898–99	0.15	4.40	2.50	3.60	12.70	5.20	15.75	1.75	3.60	0.70	0.00	1.00	*b* 51.35
1899–1900	0.00	16.05	9.15	7.90	5.25	4.75	8.15	4.80	3.97	0.50	0.25	T.	60.77
1900–1901	0.95	3.50	6.90	3.50	11.30	14.20	4.50	5.50	1.00	0.00	0.00	0.00	51.35
Mean	0.15	3.46	4.07	8.14	7.43	6.14	9.35	3.67	3.60	0.28	0.04	0.11	46.44

a Normal rainfall; record for month is missing.
b Includes the months for which rainfall has been estimated.
T. indicates trace.
Records for missing years are not obtainable.

Monthly precipitation, in inches, at Lewers's ranch, Nevada.

[Elevation, 5,177 feet.]

Season.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Total.
1889–90	.....	.....	.....	.....	.....	.....	4.39	0.28	1.04	0.00	0.00	1.42	.....
1890–91	1.28	*a* 1.71	0.29	3.55	0.31	9.30	4.65	1.72	3.04	0.19	0.11	0.47	*b* 26.62
1891–92	0.96	0.07	0.72	7.46	0.60	1.92	2.16	2.04	1.69	1.53	0.03	0.00	19.18
1892–93	0.26	0.93	9.62	5.51	4.75	3.67	3.05	1.68	1.22	0.00	0.01	0.00	30.70
1893–94	2.22	0.34	3.81	1.91	5.53	5.39	1.80	0.56	1.86	1.77	0.40	0.09	25.68
1894–95	0.14	2.51	0.36	5.28	7.92	3.08	1.22	0.98	1.56	0.21	0.00	0.10	23.36
1895–96	1.95	0.26	0.01	3.07	10.70	0.30	3.99	3.99	2.83	0.00	0.58	0.94	28.62
1896–97	0.68	0.68	3.70	2.11	2.13	5.35	4.34	0.25	0.20	0.55	0.00	0.43	20.42
1897–98	0.08	4.41	3.66	4.21	0.86	1.75	1.57	1.18	1.07	0.23	0.01	0.27	19.36
1898–99	0.18	1.41	3.39	2.40	*a* 4.17	0.69	8.51	0.65	0.15	0.06	0.01	1.21	*b* 22.83
1899–1900	0.00	2.45	3.41	5.46	0.96	1.13	2.41	4.16	*a* 1.67	*a* 0.46	1.25	0.15	*b* 23.51
1900–1901	0.87	4.06	6.68	2.05	7.93	6.33	1.96	2.20	3.71	0.49	T.	0.75	37.03
Mean	0.78	1.71	3.24	3.91	4.17	3.54	3.34	1.64	1.67	0.46	0.20	0.49	25.15

a Normal rainfall; record for month is missing
b Includes the months for which rainfall has been estimated.
T. indicates trace.

Monthly precipitation, in inches, at Marlette Lake, Nevada.

[Elevation, 7,800 feet.]

Season.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Total.
1893-94	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.30	0.23	.....
1894-95	0.38	2.22	0.60	8.77	9.10	4.75	3.49	0.95	1.92	0.00	.....	.....	.....

Records for other years are not obtainable.

Monthly precipitation, in inches, at Virginia, Nev.

[Elevation, 6,242 feet.]

Season.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Total.
1890-91	.....	.....	.....	.....	0.31	4.20	2.31	1.27	3.60	0.82	0.20	T.	.....
1891-92	1.68	T.	0.05	5.97	0.32	0.93	1.64	0.76	1.24	1.15	T.	*a* 0.09	*b* 13.83
1892-93	0.20	1.11	6.06	2.41	2.53	4.74	1.08	1.45	0.82	T.	T.	0.02	20.42
1893-94	1.68	0.10	1.26	1.11	3.54	5.14	1.40	0.46	1.62	3.27	0.32	0.24	20.14
1894-95	0.07	1.00	0.01	2.71	.....	.....	.....	.....	.....	.....	.....	.....	.....
Mean	0.91	0.55	1.85	3.05	1.67	3.75	1.61	0.98	1.82	1.31	0.13	0.09	17.71

a Normal rainfall; record for month is missing.
b Includes the months for which rainfall has been estimated.
T. indicates trace.
Records for other years are not obtainable.

Monthly precipitation, in inches, at Carson, Nev.

[Elevation, 4,670 feet.]

Season.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Total.
1888-89	0.59	0.00	2.00	0.61	0.10	0.27	1.63	0.03	1.91	0.33	0.00	0.00	7.47
1889-90	0.00	1.08	2.47	4.62	5.29	2.39	1.12	0.15	0.43	0.00	0.00	1.13	18.61
1890-91	1.01	0.03	0.01	2.31	0.10	4.18	2.55	1.85	2.80	0.29	0.21	0.00	15.34
1891-92	0.89	0.00	0.00	5.43	0.35	1.39	1.71	0.48	0.54	1.46	0.00	0.02	12.27
1892-93	0.26	0.30	5.85	1.89	3.18	2.42	1.47	1.01	0.37	0.00	0.00	0.11	16.86
1893-94	0.98	0.15	1.49	0.24	2.33	2.83	0.97	0.36	1.07	1.14	0.23	0.05	11.84
1894-95	0.05	0.29	0.22	3.24	4.59	1.96	0.32	0.40	0.73	0.02	0.00	0.04	11.86
1895-96	0.20	0.71	0.56	1.38	4.82	0.10	2.23	1.47	1.06	0.12	0.63	1.30	14.58
1896-97	0.38	0.30	1.53	0.70	1.47	4.17	2.83	0.04	0.20	0.12	0.27	0.34	12.31
1897-98	0.01	1.56	0.88	1.72	0.58	0.95	1.00	0.53	0.32	0.00	0.07	0.25	7.92
1898-99	0.15	0.67	1.39	0.13	*a* 2.09	0.35	2.29	0.30	0.52	0.07	T.	0.47	*b* 8.43
1899-1900	0.00	0.63	1.14	1.92	0.28	0.38	0.88	2.79	0.55	0.59	0.14	0.13	9.43
1900-1901	0.09	1.20	2.41	0.69	2.03	2.93	0.61	0.92	1.68	0.23	0.02	0.44	13.24
Mean	0.36	0.53	1.54	1.91	2.09	1.87	1.51	0.79	0.94	0.34	0.12	0.33	12.33

a Normal rainfall; record for month is missing.
b Includes the months for which rainfall has been estimated.
T. indicates trace.

Monthly precipitation, in inches, at Genoa, Nev.

[Elevation, 4,824 feet.]

Season.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Total.
1888-89	*a* 0.51	0.00	0.27	0.65	0.76	0.00	4.45	0.05	1.25	0.07	0.00	0.00	*b* 8.01
1889-90	0.00	2.92	5.45	7.85	6.02	2.33	3.80	0.00	0.70	0.00	0.00	0.15	29.22
1890-91	0.46	*a* 0.73	*a* 2.70	0.00	0.00	4.64	2.95	1.13	3.63	0.00	1.00	0.00	*b* 17.24
1891-92	0.80	0.00	0.00	8.46	*a* 3.38	0.31	2.45	1.35	0.30	*a* 0.02	*a* 0.25	*a* 0.20	*b* 17.54
1892-93	*a* 0.51	*a* 0.73	8.75	*a* 3.02	3.95	1.60	2.13	1.40	*a* 1.13	*a* 0.02	*a* 0.25	0.67	*b* 24.16
1893-94	0.54	0.20	3.44	0.45	2.90	2.82	0.70	0.00	0.42	*a* 0.02	*a* 0.25	0.20	*b* 11.94
1894-95	*a* 0.51	1.23	0.45	3.00	6.65	0.45	0.40	0.25	0.50	0.00	0.00	*a* 0.20	*b* 13.64
1895-96	0.75	0.00	0.53	0.72	.....	.....	.....	.....	.....	.....	.....	.....	.....
Mean	0.51	0.73	2.70	3.02	3.38	1.74	2.41	0.60	1.13	0.02	0.25	0.20	16.69

a Normal rainfall; record for month is missing.
b Includes the months for which rainfall has been estimated.
Records for other years are not obtainable.

Monthly precipitation at Glenbrook, Nev.

[Elevation, 6,240 feet.]

1901—	Inches.
January 15 to 31	0.60
February	5.10
March	1.23

The records at Reno and Wadsworth, in the lower portion of the basin, are generally applicable to the valley areas, where the water will be chiefly employed for irrigation, and show the need of an artificial supply. The records at the other stations give an idea of the rainfall in the higher portions of the basin, and serve as a basis for estimating the probable run-off from the various portions of the watershed.

The following table shows the increase in precipitation with increase in elevation:

Table showing increase in precipitation with each 100-foot rise in elevation, with Wadsworth, Nev., as a base.

Station.	Length of record.	Elevation.	Elevation above Wadsworth.	Mean precipitation.	Increase in precipitation over Wadsworth.	Constant increase for each 100 feet rise.
	Years.	*Feet.*	*Feet.*	*Inches.*	*Inches.*	*Inches.*
Wadsworth	28	4,077	0	4.48	0	
Reno	29	4,497	420	6.17	1.69	0.40
Verdi	8	4,895	818	16.37	11.89	1.45
Lewers's ranch	9	5,177	1,100	24.53	20.05	1.82
Boca	30	5,541	1,464	20.31	15.83	1.08
Truckee	30	5,819	1,742	26.65	22.17	1.27
Summit	25	7,017	1,940	43.55	39.07	2.01
Marlette Lake	1	7,800	3,723	32.71	28.23	0.76
Virginia	4	6,242	1,165	17.72	13.24	1.14
Carson	22	4,670	593	11.92	7.44	1.25
Genoa	6	4,824	747	16.84	12.36	1.65
Total						12.83
Mean						1.28

In the foregoing table, in computing the mean increase in precipitation per hundred feet rise, the same weight has been given to the record at Marlette Lake, though it covers only twelve months, as to each of the other stations. The reasons for this are: (1) For the period covered by this record the precipitation at most of the stations where observations were made was but slightly above the normal; and (2) the effect upon the mean, which is designed to serve as a basis for estimating the rainfall on various subdivisions of the Truckee Basin, is in the direction of conservatism.

DRAINAGE AREAS.

The map of the Truckee Basin (fig. 1, p. 9) was prepared from the topographic atlas sheets of the United States Geological Survey. The outlines of the various subdivisions of the basin, including the areas directly tributary to reservoir sites which are described in this report, were marked upon the topographic sheets and the areas measured by planimeter.

The following table classifies the basin of the Truckee above Pyramid and Winnemucca lakes into four parts: (1) The area above the outlet to Lake Tahoe, including the lake surface of 193 square miles, which would be tributary to that basin if utilized as a reservoir; (2) intermediate basins, including that of Little Truckee River between Lake Tahoe and Stateline Mills; (3) the area between Stateline Mills and Vista, including Steamboat Creek and Washoe Lake; and (4) the drainage area below Vista:

Drainage areas of Truckee River.

	Sq. m.	
Tahoe Basin, exclusive of Marlette Lake drainage:		
In California	382	
In Nevada	137	
Total		519
Above Stateline Mills and below Lake Tahoe:		
Squaw Creek	8	
Donner and Cold creeks	31	
Martis Creek	42	
Prosser Creek	56	
Little Truckee River	179	
Juniper Creek	10	
Joe Gray Creek	18	
Alder Creek	18	
Other small tributaries between Lake Tahoe and Stateline Mills	74	
Total		436
Total above Stateline Mills		955
Dog Valley Creek above dam site	16	
Hunter Creek	12	
Steamboat Creek above Steamboat Springs	123	
Other areas between Stateline Mills and Vista	413	
Total		564
Total above Vista		1,519
Total below Vista		611
Total drainage area		2,130
Total in California		790
Total in Nevada		1,340

RUN-OFF AND STREAM FLOW.

During the spring of 1889 measurements of stream flow in the Truckee Basin were begun by the United States Irrigation Survey, a branch of the United States Geological Survey. This season is remembered throughout the State of Nevada as the second and drier of two dry years preceding the winter of 1889 and 1890, known as "the hard winter," from which all subsequent occurrences are dated by the people of the region, who consider it the drier season ever known. During the early part of that year the precipitation at the headwaters

of Truckee River was very light, but about the middle of May there was a heavy snowstorm, followed by warm weather, causing floods of short duration, which were followed by unusually low water during the summer and fall. The results of the measurements made by the Irrigation Survey are here given, beginning at the outlet of Lake Tahoe and taking the various tributaries in order:[1]

Discharge measurements of Truckee River at outlet of Lake Tahoe during 1889.

	Sec.-ft.
July 9	136
August 8	75
August 14	56
August 18	49

The maximum for the year is estimated at 170 second-feet.

A stream entering the Truckee from the west about halfway between Lake Tahoe and Truckee, known as Squaw Creek, on June 3, 1889, was discharging 92 second-feet, and on June 22, 1889, 15 second-feet. The creek near Tahoe tollgate was discharging 74 second-feet on June 3, 1889.

Donner Creek is the outlet of Donner Lake. About three-fourths of a mile below the lake it is joined by Cold Creek, which flows in from the south. The following measurements were made during 1889:

Discharge measurements, in second-feet, of Donner and Cold creeks during 1889.

Stream.	June 28.	July 3.	July 6.	July 11.	July 16.	Aug. 7	Aug. 10.	Aug. 17.
Donner Creek	.....	8	5	2	1	0.9	0.2	0.3
Cold Creek	11	10	5	1	.....	1.0	1.0	0.7
Total	.....	18	10	3	.....	1.9	1.2	1.0

More detailed measurements were made of Prosser Creek, the outlet of Twin Valley, and of Little Truckee River, which receives the drainage of Independence and Webber lakes and joins the Truckee at Boca. (See tables of monthly discharge on pages 19 to 22.) Other small tributaries were measured during the year, when they were at about their maximum, except Dog Valley Creek and the second measurement of Martis Creek, the results being as follows:

Discharge measurements of small tributaries of Truckee River during 1889.

Date.	Stream.	Point of measurement.	Discharge.
			Sec.-ft.
June 1	Martis Creek		19
June 22	do		7
May 30	Juniper Creek	Clinton	32
May 31	Joe Gray Creek	Iceland	88
May 31	Alder Creek	Floriston	42
May 22	Dog Valley Creek	Verdi	7

[1] Eleventh Ann. Rept. U. S. Geol. Survey, Pt. II.

Measurements on the main stream were begun in May, 1889, at Essex, Nev., about 12 miles above Reno, the results being as follows:

Discharge measurements of Truckee River at Essex, Nev., during 1889.

	Sec.-ft.
May 20	2,330
May 21	2,570
May 22	2,510
May 29	1,716
June 20	350

The maximum flow for the year was on May 21. The mean for the last ten days of May was 2,134 second-feet, for June 771 second-feet, for July 278 second-feet, and for August and September 200 second-feet; the latter results, however, are doubtful. In the spring of 1890 the Essex station was abandoned and gagings were made a mile below Boca, also at Laughton's, 6 miles above Reno, and at Vista, 8 miles east of Reno.

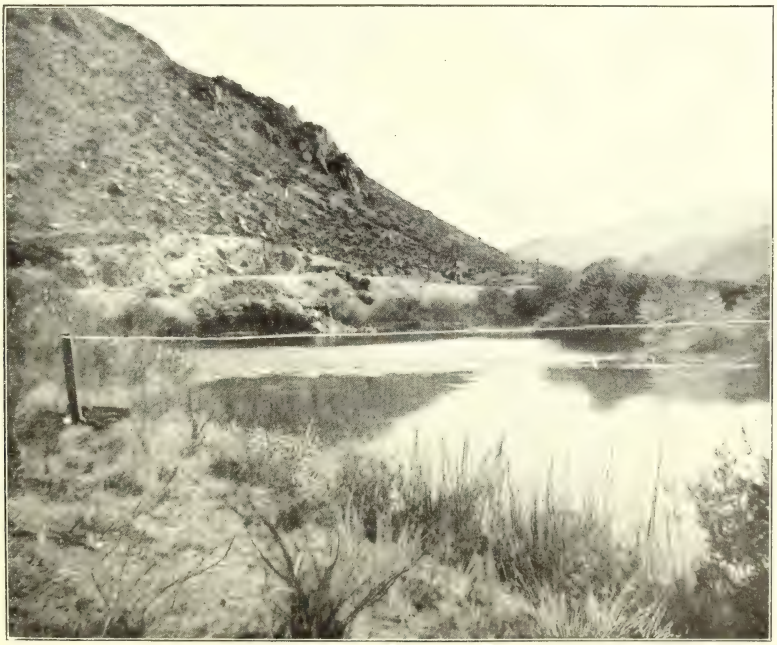
On July 3, 1895, the United States Geological Survey began keeping a record of the flow of Truckee River where it issues from Lake Tahoe,[1] for the purpose of obtaining data regarding the value of that lake for storage purposes, it being certain that the volume of water flowing out of the lake from year to year would be the amount yielded by the watershed, less evaporation, and consequently the quantity available for storage. Unfortunately lack of funds necessitated the discontinuance of these observations. While the conditions were not the most favorable for accurate measurements, the results exhibited in the following tables of monthly stream discharge approximate the truth.

In the month of August, 1899, a station was established on Truckee River at Vista (see Pl. II, *B*), below the Truckee Meadows, for the purpose of measuring the stream discharge at that point; and in the following month a similar station was established at Stateline Mills (see Pl. II, *A*), above all the irrigating canals diverting water from the river. Observations at these stations have been made daily up to December 31, 1901. On May 31, 1900, measurements of the flow of Steamboat Creek, the outlet of the Washoe Lake basin, were begun at Steamboat Springs, where the stream enters the Reno Valley.

During the early part of the year 1900 the outlet of Lake Tahoe into Truckee River was kept closed, but from the time the gates in the dam there were opened, in the latter part of June, a daily record of the outflow has been kept, the results of which are given, as are those of the gagings at the three other stations mentioned in the accompanying tables (pages 22 to 31). The tables also give the run-off in acre-feet, in second-feet per square mile of drainage area, and in depth in inches for each month.

[1] Bull. U. S. Geol. Survey No. 140.

A. TRUCKEE RIVER AT STATELINE MILLS, CALIFORNIA.



B. TRUCKEE RIVER AT VISTA, NEV., GAGING STATION.

Estimated monthly discharge of Truckee River at Tahoe, Cal.

[Drainage area, 519 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
1895.						
July	1,185	442	914	56,200	1.761	1.897
August	441	393	425	26,111	0.819	0.943
September	392	357	374	22,244	0.721	0.803
October	496	344	415	25,538	0.800	0.923
November	471	408	437	26,002	0.842	0.940
December	253	246	250	15,388	0.482	0.556
1896.						
January	293	244	262	16,102	0.500	0.582
February	292	288	290	16,677	0.560	0.602
1900.						
June	236	0	52	3,106	0.101	0.112
July	260	0	214	13,131	0.412	0.474
August	260	211	232	14,261	0.447	0.532
September	224	177	196	11,667	0.378	0.434
October	177	155	159	9,781	0.307	0.364
November	200	0	135	8,047	0.261	0.291
December	99	0	81	4,981	0.156	0.180
1901.						
January	117	85	102	6,262	0.196	0.226
February	117	30	81	4,592	0.156	0.163
March	30	30	30	1,845	0.058	0.067
April	30	0	9	565	0.018	0.020
May	0	0	0	0	0	0
June	178	0	30	1,765	0.058	0.064
July	233	156	225	13,809	0.433	0.499
August	555	293	419	25,760	0.807	0.931
September	390	117	326	19,395	0.628	0.701
October	308	251	282	17,308	0.542	0.625
November	293	189	247	14,678	0.475	0.530
December	189	100	111	6,841	0.214	0.247
The year	555	0	155	112,730	0.299	4.073

Estimated monthly discharge of Truckee River at Stateline Mills, Cal.

[Drainage area, 955 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
1899.						
September 7 to 30	338	267	276	16,423	0.288	0.322
October	628	267	330	20,273	0.345	0.398
November	1,562	267	570	33,894	0.596	0.665
December	301	235	267	16,429	0.280	0.323
1900.						
January	421	267	376	23,100	0.393	0.453
February	338	235	291	16,187	0.310	0.318
March	1,171	267	810	49,833	0.849	0.978
April	1,429	741	927	55,133	0.970	1.084
May	1,840	1,235	1,529	94,023	1.601	1.846
June	1,429	301	966	57,496	1.012	1.129
July	520	379	441	27,101	0.462	0.532
August	470	338	373	22,929	0.390	0.451
September	470	180	344	20,470	0.360	0.402
October	921	206	462	28,426	0.484	0.558
November	921	301	463	27,573	0.485	0.541
December	1,171	180	380	23,346	0.280	0.323
The year	1,840	180	614	445,617	0.633	8.615
1901.						
January	559	230	314	19,308	0.329	0.379
February	3,435	247	1,082	60,092	1.133	1.176
March	2,280	732	1,280	78,706	1.340	1.544
April	2,505	613	1,476	87,829	1.545	1.728
May	4,370	1,508	2,478	152,370	2.595	2.992
June	2,505	989	1,595	94,910	1.670	1.862
July	1,194	421	686	42,181	0.718	0.828
August	795	349	486	29,884	0.509	0.588
September	559	247	472	28,086	0.494	0.552
October	559	247	470	28,900	0.492	0.566
November	613	383	469	27,908	0.491	0.549
December	1,194	247	445	27,347	0.466	0.535
The year	4,370	230	938	677,521	0.982	13.300

Estimated monthly discharge of Truckee River near Vista, Nev.

[Drainage area, 1,519 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
1890.						
April 26 to 30	5,610	3,730	4,496	267,512	2.96	3.30
May	7,510	3,200	5,990	368,385	3.94	4.55
June	6,710	3,115	4,162	247,639	2.74	3.06
July	3,730	1,185	2,198	135,177	1.45	1.67
August	1,152	750	952	58,548	0.63	0.72
September	825	570	682	40,579	0.45	0.50
October	1,030	490	742	45,633	0.49	0.56
November	825	400	765	45,517	0.50	0.56
December			*a* 750	46,125	0.49	0.57
1891.						
January			*a* 700	43,050	0.46	0.54
February			*a* 650	36,075	0.43	0.44
March			*a* 650	39,975	0.43	0.50
April 26 to 30	3,115	570	1,523	90,618	1.00	1.12
May	3,285	1,990	2,765	170,047	1.79	2.10
June	2,730	1,280	1,905	113,347	1.25	1.39
July			945	58,108	0.62	0.72
August			485	27,423	0.32	0.37
September			558	33,165	0.36	0.41
October			561	34,696	0.37	0.43
November			503	29,929	0.33	0.37
December			508	32,137	0.31	0.39
The year			980	708,570	0.64	8.78
1892.						
January			593	36,064	0.39	0.45
February			505	29,048	0.33	0.36
March			723	44,467	0.48	0.56
April			854	50,813	0.56	0.63
May			937	59,616	0.62	0.71
1899.						
August, 18 to 31	188	74	114			
September	188	74	152	9,073	0.100	0.111
October	1,066	144	378	23,251	0.249	0.287
November	1,123	355	516	30,713	0.340	0.379
December	709	331	456	28,019	0.300	0.346
1900.						
January	1,210	380	479	29,445	0.315	0.363
February	529	380	426	23,671	0.281	0.292
March	1,094	454	857	52,668	0.564	0.650
April	1,239	479	756	44,982	0.498	0.555
May	1,477	843	1,257	77,289	0.827	0.954
June	1,239	259	709	42,201	0.467	0.521
July	307	74	110	6,746	0.072	0.083
August	283	61	122	7,513	0.080	0.093
September	283	105	192	11,449	0.127	0.141
October	1,123	258	430	26,456	0.283	0.326
November	1,298	331	566	33,660	0.372	0.415
December	1,268	429	554	34,049	0.364	0.420
The year	1,477	61	538	390,129	0.354	4.813
1901.						
January	1,505	418	661	40,644	0.435	0.502
February	4,213	418	1,486	82,529	0.978	1.019
March	2,209	938	1,328	81,657	0.874	1.008
April	1,942	747	1,380	82,117	0.908	1.014
May	4,213	1,410	2,145	131,894	1.412	1.628
June	1,942	854	1,263	75,155	0.831	0.928
July	995	146	425	26,133	0.280	0.323
August	492	128	315	19,369	0.207	0.227
September	467	251	329	19,577	0.217	0.242
October	720	370	477	29,330	0.314	0.362
November	882	467	557	33,144	0.367	0.409
December	1,287	322	510	31,357	0.336	0.387
The year	4,213	128	906	652,906	0.597	8.049

a Estimated.

Estimated monthly discharge of Steamboat Creek at Steamboat Springs, Nev.

[Drainage area, 123 square miles.]

Month.	Discharge in second-feet.				Run-off.	
	Maximum.	Minimum.	Mean.	Total in acre-feet.	Second-feet per square mile.	Depth in inches.
1900.						
May 30 and 31	23.4	23.4	23.4			
June	50.0	4.0	25.0	1,497	0.205	0.228
July	14.0	5.0	7.3	448	0.059	0.068
August	4.0	2.0	3.0	174	0.023	0.026
September	4.0	1.0	2.5	147	0.020	0.023
October	14.0	2.0	5.4	333	0.044	0.051
November	75.0	8.0	11.4	670	0.093	0.103
December	14.0	8.0	8.2	506	0.066	0.077
1901.						
January	56.0	3.0	7.6	467	0.061	0.071
February	72.0	3.0	15.6	866	0.126	0.132
March	20.5	5.0	10.8	664	0.087	0.101
April	11.5	3.0	7.7	458	0.062	0.069
May	29.5	11.5	21.4	1,316	0.174	0.200
June	39.0	17.0	29.6	1,761	0.240	0.268

Estimated monthly discharge of Prosser Creek near Boca, Cal.

[Drainage area, 56 square miles.]

Month.	Discharge in second-feet.				Run-off.	
	Maximum.	Minimum.	Mean.	Total in acre-feet.	Second-feet per square mile.	Depth in inches.
1889.						
April			*a* 100	5,950	1.79	2.00
May			259	15,900	4.62	5.34
June			110	6,540	1.96	2.20
July			17	1,050	0.31	0.35
August			3	185	0.06	0.06
September			2	123	0.04	0.04
December						9.99
1890.						
May 19 to 31	1,230	615	817	50,245	14.45	16.34
June			580	34,510	10.40	11.67
July	865	120	382	23,493	6.82	7.86
August	120	75	102	6,273	1.82	2.10

a Estimated.

Estimated monthly discharge of Little Truckee River near Boca, Cal.

[Drainage area, 179 square miles.]

Month.	Discharge in second-feet.				Run-off.	
	Maximum.	Minimum.	Mean.	Total in acre-feet.	Second-feet per square mile.	Depth in inches.
1890.						
April	2,646	276	958	57,066	5.36	5.90
May	2,867	1,000	1,998	122,914	11.15	12.85
June	1,840	1,005	1,491	89,438	8.33	9.36
July	1,330	295	749	45,975	4.18	4.81
August	390	110	200	12,300	1.12	1.28
September	150	87	97	5,771	0.54	0.60
October	108	70	86	5,289	0.48	0.55

Estimated monthly discharge of Truckee River near Boca, Cal.

[Drainage area, 902 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
1890.						
March 24 to 31	755	545	637	39,175	0.71	0.81
April	5,716	580	2,751	163,684	3.05	3.40
May	7,172	2,908	5,275	324,412	5.85	6.74
June	5,092	2,596	4,291	255,314	4.76	5.30
July	2,596	930	1,870	115,005	2.07	2.39
August	910	510	736	45,264	0.82	0.94
September	580	495	513	30,523	0.57	0.63
October	610	490	555	34,132	0.62	0.71

Estimated monthly discharge of Truckee River near Essex, Nev.

[Drainage area, 991 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
1889.						
May			*a* 2,314	131,241	2.15	2.48
June			771	45,874	0.78	0.87
July			278	17,097	0.28	0.32
August			*a* 200	12,300	0.20	0.23
September			*a* 200	11,900	0.20	0.22

a Estimated.

At Vista observations of the flow of Truckee River were carried on during fifty-five months extending through six years. During four of the years records were kept for the months of January, February, March, June, and July, while for the remaining months observations were made during five years. The results of the observations for several months of the years 1890 and 1891 are claimed to be only rough approximations, so, while the record is not sufficient to show the normal discharge of the river at Vista, the following table, compiled from the data already given, is of value in connection with the study of irrigation possibilities farther down the stream:

Estimated mean monthly, annual, and mean annual discharge of Truckee River at Vista, Nev.

[Drainage area, 1,519 square miles.]

	Jan.	Feb.	Mar.	Apr.	May.	June.
DISCHARGE IN SECOND-FEET.						
1890				4,496	5,990	4,162
1891	*a* 700	*a* 650	*a* 650	1,523	2,765	1,905
1892	593	505	723	854	937	
1899						
1900	479	426	857	756	1,257	709
1901	661	1,486	1,328	1,380	2,145	1,263
Mean	608	767	890	1,802	2,619	2,010
RUN-OFF.						
Run-off, second-feet per square mile	0.400	0.505	0.586	1.186	1.724	1.323
Run-off in inches	0.461	0.526	0.676	1.324	1.988	1.476
Acre-feet	37,385	42,598	54,725	107,228	161,638	119,560

Estimated mean monthly, annual, and mean annual discharge of Truckee River at Vista, Nev.—Continued.

	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
DISCHARGE IN SECOND-FEET.							
1890	2,198	952	682	742	765	*a* 750	.....
1891	945	485	558	561	503	508	979
1892	.....	.....	.....	.....	.....	.....	.....
1899	.....	114	152	373	516	546	.....
1900	110	122	192	430	566	554	538
1901	425	315	329	477	557	510	906
Mean	920	398	383	517	581	556	1,004
RUN-OFF.							
Run-off, second-feet per square mile	0.606	0.262	0.252	0.340	0.382	0.366	0.661
Run-off in inches	0.698	0.302	0.281	0.392	0.427	0.422	8.973
Acre-feet	56,569	24,472	22,780	31,790	34,572	34,188	726,950

a Approximate.

The following tables show the daily mean discharge of Truckee River at the three stations where observations have been carried on by the United States Geological Survey during the years 1895, 1896, 1899, 1900, and 1901.

Daily mean discharge, in second-feet, of Truckee River at Tahoe, Cal., for 1895

[Drainage area, 519 square miles; observer, P. Wehrman.]

Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	441	392	357	471	253
2	.....	439	391	356	466	253
3	1,180	438	390	356	463	252
4	1,180	437	389	355	460	251
5	1,180	436	387	353	459	251
6	1,180	435	384	352	456	251
7	1,185	435	381	350	454	250
8	1,185	434	379	349	451	250
9	1,185	434	377	348	450	249
10	1,185	434	374	347	447	249
11	1,180	433	377	347	445	249
12	1,180	432	381	346	442	249
13	1,180	432	379	345	441	248
14	1,180	431	377	344	438	248
15	1,180	430	376	434	435	248
16	1,180	430	376	432	432	247
17	1,178	429	374	430	429	246
18	1,175	427	373	429	428	248
19	1,167	426	372	426	427	249
20	1,159	425	371	496	426	251
21	266	424	371	494	424	253
22	587	423	368	493	423	253
23	587	422	364	490	423	253
24	585	422	361	488	421	253
25	585	416	360	486	420	253
26	448	409	359	483	419	252
27	447	403	359	482	416	251
28	446	400	358	480	414	251
29	445	399	358	478	411	250
30	444	395	357	475	408	249
31	442	393	.....	474	....	248
Total	26,511	13,164	11,215	12,875	13,109	7,758
Mean	914.2	425	374	415	437	250
Run-off per square mile	1.761	0.819	0.721	0.800	0.800	0.842
Run-off in inches	1.897	0.943	0.803	0.923	0.940	0.556
Total in acre-feet	56,200	26,110	22,243	25,537	26,002	15,387

Estimated daily discharge, in second-feet, of Truckee River at Tahoe, Cal., for 1896.

[Observer, P. Wehrman.]

Day.	Jan.	Feb.	Day.	Jan.	Feb.	Day.	Jan.	Feb.
1	248	292	15	244	290	29	293	290
2	248	292	16	245	290	30	293	.....
3	247	292	17	246	290	31	292	.....
4	246	291	18	253	290			
5	246	291	19	264	289	Total	8,118	8,408
6	246	291	20	271	289			
7	246	291	21	276	289	Mean	262	290
8	245	291	22	281	288	Run-off per square mile	0.50	0.56
9	245	290	23	284	288	Run-off in inches	0.582	0.602
10	245	290	24	284	288			
11	245	290	25	284	289			
12	245	290	26	286	289			
13	544	290	27	290	289	Total in acre-feet	16,102	16,677
14	244	290	28	292	289			

Estimated daily discharge, in second-feet, of Truckee River at Tahoe, Cal., for 1900.

[Observer, J. U. Haley.]

Day	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	.....	260	211	177	155	0
2	.....	236	260	211	165	155	99
3	.....	236	260	200	165	155	99
4	.....	0	248	200	165	155	72
5	.....	236	260	200	177	155	72
6	.....	236	248	200	177	155	99
7	.....	236	248	224	165	155	99
8	.....	0	248	211	165	155	99
9	.....	236	236	211	165	155	99
10	.....	236	236	211	155	155	99
11	.....	236	236	200	155	155	99
12	.....	236	236	200	155	155	99
13	.....	236	236	200	155	155	99
14	.....	236	236	200	155	155	99
15	.....	92	236	200	155	155	99
16	.....	248	236	188	155	155	99
17	92	236	236	177	155	155	72
18	92	248	236	211	155	155	72
19	92	236	224	200	155	155	72
20	92	248	236	211	155	155	72
21	.....	248	224	200	155	177	72
22	99	248	224	200	155	200	72
23	.....	248	224	177	155	116	72
24	.....	248	224	177	155	116	72
25	155	248	224	177	155	116	72
26	.....	248	224	177	155	116	72
27	236	236	224	177	155	116	72
28	236	236	224	177	155	0	72
29	236	248	224	177	155	0	72
30	236	248	211	177	155	0	72
31	.....	260	211	.....	155	.....	72
Total	1,562	6,620	1,190	5,882	4,931	4,057	2,511
Mean	52.2	214	231.9	196.1	159.1	135.23	81
Run-off per square mile	0.106	0.474	0.532	0.434	0.364	0.291	0.156
Run-off in inches	0.101	0.412	0.447	0.378	0.307	0.261	0.180
Total in acre-feet	3,106	13,131	14,261.4	11,666.9	9,780.6	8,047.06	4,980.6

Estimated daily discharge, in second-feet, of Truckee River at Tahoe, Cal., for 1901.

[Observer, J. U. Haley.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	85	100	30	30	.....	.....	178	293	390	293	293	189
2	85	100	30	30	.....	.....	178	293	390	293	279	126
3	85	100	30	30	.....	.....	178	293	390	293	279	126
4	100	100	30	30	.....	.....	178	293	390	293	279	126
5	100	100	30	30	.....	.....	178	339	390	293	279	126
6	100	100	30	30	.....	.....	178	339	390	293	279	126
7	100	117	30	36	.....	.....	178	407	372	279	279	126
8	100	117	30	36	.....	.....	156	407	372	251	279	126
9	100	117	30	36	.....	.....	156	407	372	308	279	126
10	117	100	30	36	.....	.....	178	531	372	308	279	126
11	117	100	30	36	.....	.....	178	555	372	293	279	126
12	117	117	30	36	.....	.....	189	555	323	000	279	100
13	117	117	30	36	.....	.....	189	555	323	293	279	100
14	117	117	30	.....	.....	.....	189	555	117	293	279	100
15	117	117	30	.....	.....	.....	189	555	225	293	279	100
16	100	117	30	.....	.....	.....	189	555	308	279	279	100
17	100	117	30	.....	.....	.....	189	555	308	279	279	100
18	100	117	30	.....	.....	.....	189	555	308	279	279	100
19	100	30	30	.....	.....	.....	279	390	308	279	279	100
20	100	30	30	.....	.....	.....	279	390	308	279	189	100
21	100	30	30	.....	.....	.....	279	390	308	279	189	100
22	100	30	30	.....	.....	.....	279	265	308	279	189	100
23	100	30	30	.....	.....	.....	279	390	308	308	189	100
24	100	30	30	.....	.....	.....	279	390	308	308	189	100
25	100	30	30	.....	.....	.....	293	390	308	308	189	100
26	100	30	30	.....	.....	178	293	390	308	308	189	100
27	100	30	30	.....	.....	178	293	390	308	293	189	100
28	100	.....	30	.....	.....	178	293	390	308	293	189	100
29	100	.....	30	.....	.....	178	293	390	293	293	189	100
30	100	.....	30	.....	.....	178	293	390	293	293	189	100
31	100	.....	30	.....	.....	.....	293	390	.....	293	.....	100
Total	3,157	2,270	930	432	000	890	6,962	12,987	9,778	8,726	7,400	3,449
Mean	102	81	30	14	000	30	225	419	326	282	247	111
Run-off per square mile	0.196	0.156	0.058	0.027	000	0.058	0.499	0.931	0.701	0.625	0.530	0.247
Run-off in inches	0.226	0.163	0.067	0.030	000	0.064	0.433	0.807	0.628	0.542	0.475	0.214
Total in acre-feet	6,262	4,502	1,845	833	000	1,765	13,809	25,760	19,395	17,308	14,678	6,841

Estimated daily discharge, in second-feet, of the Truckee River at Stateline Mills, California, for 1899.

[Drainage area, 955 square miles; observer, H. A. Grant.]

Day.	Sept.	Oct.	Nov.	Dec.
1		267	338	267
2		267	338	267
3		267	301	267
4		267	301	267
5		267	301	267
6		267	573	235
7	301	267	684	235
8	301	267	921	235
9	267	267	1,299	267
10	267	267	1,429	267
11	267	267	1,562	267
12	267	301	1,108	267
13	267	301	800	301
14	267	301	628	301
15	267	267	741	301
16	338	267	628	267
17	301	267	628	267
18	267	267	520	267
19	267	267	520	267
20	267	470	423	267
21	267	520	379	267
22	267	628	338	267
23	267	520	301	267
24	301	470	301	267
25	267	423	301	267
26	267	379	301	267
27	267	338	301	267
28	267	301	301	267
29	267	301	267	267
30	267	338	267	267
31		338		267
Total	6,615	10,221	17,088	8,283
Mean	275.6	329.7	569.6	267.2
Run-off per square mile	0.289	0.345	0.596	0.280
Run-off in inches	0.32	0.398	0.665	0.323
Total in acre-feet	16,400	20,273.35	33,894.05	16,429.33

Estimated daily discharge, in second-feet, of Truckee River at Stateline Mills, California, for 1900.

[Observer, H. A. Grant.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	267	267	301	1,045	1,429	1,235
2	301	267	267	921	1,429	1,235
3	684	267	267	800	1,299	1,171
4	921	267	301	800	1,429	1,171
5	684	267	301	921	1,630	1,108
6	628	235	301	921	1,429	1,235
7	423	235	423	921	1,495	1,235
8	338	235	470	741	1,630	1,429
9	301	235	573	741	1,699	1,429
10	301	235	573	800	1,840	1,235
11	301	235	573	800	1,840	1,235
12	301	267	741	1,045	1,429	1,171
13	338	301	800	1,171	1,299	1,429
14	423	301	1,045	1,171	1,299	1,235
15	379	301	1,171	921	1,630	921
16	379	301	1,045	921	1,699	921
17	379	301	1,045	921	1,699	921
18	379	301	921	860	1,769	921
19	379	301	1,045	800	1,769	860
20	379	338	1,045	741	1,840	800
21	301	338	1,171	741	1,699	800
22	301	338	1,108	1,108	1,769	741
23	267	338	1,045	860	1,699	800
24	267	338	1,045	800	1,429	301
25	267	338	1,045	983	1,429	628
26	267	338	1,171	1,108	1,429	628
27	267	338	1,171	860	1,299	573
28	267	338	1,045	800	1,299	573
29	267	.....	1,045	1,045	1,299	573
30	267	.....	1,045	1,429	1,235	573
31	267	.....	1,045	.....	1,235	.....
Total	11,490	8,161	25,124	27,796	47,403	28,987
Mean	370.7	291.46	810.45	926.53	1,529.13	966.23
Run-off per square mile	0.453	0.318	0.978	1.084	1.846	1.129
Run-off in inches	0.393	0.310	0.849	0.970	1.601	1.012
Total in acre-feet	23,099.84	16,187.34	49,833.45	55,133.37	94,023.85	57,495.71

Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	520	338	470	423	423	180
2	520	338	301	301	301	180
3	520	338	235	338	301	180
4	470	338	470	338	470	235
5	470	338	379	379	470	235
6	470	338	423	379	470	235
7	470	338	379	423	628	301
8	470	338	338	379	520	301
9	470	338	338	379	470	379
10	470	338	338	338	470	379
11	470	338	338	301	470	379
12	470	338	379	301	470	379
13	470	338	379	301	470	379
14	470	338	423	301	423	301
15	470	338	423	301	379	301
16	470	338	423	423	379	301
17	423	338	423	206	379	301
18	379	338	423	301	379	301
19	379	379	423	423	379	301
20	423	379	423	921	379	1,171
21	423	379	338	860	520	800
22	423	470	301	800	921	800
23	423	470	301	741	800	741
24	423	470	180	741	684	301
25	423	470	180	684	520	379
26	379	301	180	684	520	379
27	379	379	301	628	423	301
28	379	379	206	628	301	301
29	379	470	267	470	301	301
30	379	470	338	301	301	379
31	379	470	.....	338	.....	301
Total	13,663	11,560	10,320	14,331	13,901	11,770
Mean	440.74	372.9	344	462.3	463.37	379.7
Run-off per square mile	0.532	0.451	0.402	0.558	0.541	0.458
Run-off in inches	0.462	0.390	0.360	0.484	0.485	0.397
Total in acre-feet	27,100.56	22,929.26	20,469.72	28,425.54	27,572.63	23,345.8

Estimated daily discharge, in second-feet, of Truckee River at Stateline Mills, Cal., for 1901.

[Observer, W. A. Pennell.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	292	247	2,069	859	1,870	2,173
2	292	247	2,280	1,123	1,594	2,391
3	383	268	1,775	924	1,508	2,505
4	421	268	1,775	732	1,594	2,391
5	559	247	1,775	989	1,775	2,173
6	247	268	1,775	732	2,173	2,069
7	349	292	1,870	732	2,623	2,173
8	319	292	1,594	732	2,623	2,173
9	319	268	1,683	732	2,745	1,870
10	319	247	1,425	613	2,391	1,594
11	319	268	1,345	732	2,623	1,425
12	383	247	1,194	1,123	4,370	1,345
13	292	292	1,055	613	4,153	1,268
14	268	292	859	1,425	4,153	1,123
15	292	319	989	1,683	3,768	1,268
16	292	319	989	1,683	3,768	1,345
17	268	989	989	1,594	3,953	1,268
18	268	1,194	732	1,870	4,153	1,425
19	292	1,194	924	1,968	3,002	1,508
20	268	3,002	989	2,173	2,505	1,508
21	319	3,435	989	2,173	2,069	1,508
22	319	1,968	1,268	2,173	1,775	1,508
23	292	2,623	1,194	1,968	1,683	1,508
24	292	2,391	1,123	1,968	1,683	1,345
25	319	2,173	1,123	2,505	1,683	1,123
26	292	2,280	1,194	2,280	1,683	1,055
27	292	2,391	1,123	1,968	1,594	989
28	319	2,280	1,055	2,069	1,775	1,194
29	349	.....	859	2,173	1,683	1,268
30	268	.....	795	1,968	1,870	1,345
31	230	.....	859	.....	1,968	.....
Total	9,733	30,301	39,668	44,277	76,810	47,838
Mean	314	1,082	1,280	1,476	2,478	1,595
Run-off per square mile	0.329	1.133	1.340	1.545	2.595	1.670
Run-off in inches	0.379	1.176	1.544	1.728	2.992	1.862
Total in acre-feet	19,308	60,092	78,706	87,829	152,370	94,910

Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1,194	463	463	463	559	613
2	1,194	509	509	463	509	613
3	1,123	421	509	509	383	1,055
4	924	383	509	509	421	1,194
5	732	349	559	509	463	795
6	732	463	509	463	509	859
7	732	509	509	463	463	613
8	671	509	383	463	463	509
9	671	421	383	509	463	509
10	732	463	509	559	421	463
11	671	421	509	559	463	349
12	671	421	509	463	463	292
13	732	421	559	247	509	268
14	671	421	421	463	463	383
15	671	421	247	463	463	319
16	613	383	349	463	463	292
17	617	732	463	421	421	292
18	613	795	463	421	463	292
19	559	795	463	463	463	319
20	613	509	509	292	463	292
21	509	509	463	421	463	268
22	613	383	463	421	421	349
23	613	421	463	421	421	383
24	613	463	509	421	421	383
25	613	509	559	463	463	319
26	613	463	463	463	509	247
27	559	509	463	559	463	292
28	463	559	463	559	463	292
29	613	463	463	559	559	292
30	509	463	509	559	613	349
31	421	509	.....	559	.....	292
Total	21,275	15,060	14,152	14,570	14,084	13,787
Mean	686	486	472	470	469	445
Run-off per square mile	0.828	0.588	0.552	0.566	0.549	0.538
Run-off in inches	0.718	0.509	0.494	0.492	0.491	0.466
Total in acre-feet	42,181	29,884	28,086	28,900	27,908	27,34[illegible]

Estimated daily discharge, in second-feet, of Truckee River at Vista, Nev., for 1899.

[Drainage area, 1,519 square miles; observer, Sam Nelson.]

Day	Aug.	Sept.	Oct.	Nov.	Dec.
1		89	144	429	355
2		74	166	429	331
3		105	166	380	380
4		105	166	380	404
5		105	166	380	380
6		105	166	380	380
7		105	166	429	380
8		105	166	429	331
9		119	166	479	331
10		144	166	479	380
11		119	166	580	380
12		144	225	1,123	631
13		144	331	953	529
14		119	380	683	478
15		166	331	683	709
16		188	331	898	631
17		166	380	843	529
18	105	144	380	683	478
19	144	144	331	631	478
20	188	144	331	529	478
21	105	144	1,066	479	380
22	144	144	898	429	380
23	105	144	580	380	380
24	144	144	529	429	404
25	119	144	479	429	404
26	105	144	479	429	404
27	105	144	479	429	429
28	74	144	479	380	529
29	89	144	479	355	6[illegible]3
30	89	144	479	355	5[illegible]0
31	74		429		580
Total	1,590	4,574	11,722	15,484	14,126
Mean	113.6	152.47	378.13	516.13	455.68
Run-off per square mile		0.100	0.249	0.340	0.300
Run-off in inches		0.111	0.287	0.379	0.346
Total in acre-feet		9,072.53	23,250.59	30,712.51	28,019.3

Estimated daily discharge, in second-feet, of Truckee River at Vista, Nev., for 1900.

[Observer, Sam Nelson.]

Day.	Jan.	Feb.	Mar.	Apr	May.	June.
1	504	429	454	898	1,417	789
2	479	429	479	953	1,417	898
3	1,210	429	479	898	1,477	843
4	1,094	380	479	789	1,298	1,152
5	816	380	479	789	1,123	898
6	683	404	529	736	1,417	898
7	657	429	580	736	1,447	898
8	631	429	657	736	1,477	1,239
9	479	380	762	683	1,387	981
10	479	380	789	631	1,477	898
11	529	429	816	631	1,477	870
12	529	429	843	631	1,477	870
13	580	454	925	580	1,009	898
14	529	454	1,009	529	981	1,123
15	554	479	1,009	529	1,210	843
16	529	504	1,009	529	1,447	736
17	504	529	1,066	479	1,357	631
18	479	380	1,066	479	1,268	631
19	479	380	1,066	479	1,357	529
20	479	380	1,066	529	1,447	580
21	479	429	1,094	1,239	1,327	504
22	504	429	1,094	1,239	1,327	454
23	479	454	1,065	843	1,268	429
24	429	454	1,009	789	1,123	429
25	429	429	1,009	789	1,037	429
26	429	429	1,009	789	1,009	404
27	380	429	953	843	1,066	404
28	380	454	953	898	981	404
29	380	.....	953	843	1,009	259
30	429	.....	953	1,123	1,009	355
31	404	.....	898	.....	843	.....
Total	14,845	11,934	26,553	22,678	38,966	21,276
Mean	478.87	426.21	856.55	755.93	1,256.97	709.2
Run-off per square mile	0.315	0.281	0.564	0.489	0.827	0.467
Run-off in inches	0.363	0.292	0.650	0.555	0.954	0.521
Total in acre-feet	29,445.06	23,671.09	52,667.88	44,981.8	77,289.06	42,200.94

Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	307	61	144	166	479	529
2	259	61	105	258	504	580
3	188	74	144	283	529	504
4	188	61	283	331	331	479
5	188	74	283	454	360	529
6	188	48	283	454	380	529
7	166	61	211	429	404	429
8	144	61	188	429	429	504
9	144	61	188	429	429	504
10	105	74	166	283	479	479
11	105	74	144	331	479	479
12	105	74	188	360	479	479
13	74	74	235	380	479	479
14	74	105	166	331	429	429
15	90	125	188	331	479	479
16	74	144	188	360	580	479
17	105	125	235	380	529	479
18	74	74	188	454	529	429
19	48	188	188	429	504	504
20	38	144	259	1,123	529	554
21	38	144	235	580	1,123	1,268
22	38	211	188	580	1,298	1,123
23	48	235	188	554	1,066	736
24	144	235	144	504	736	580
25	74	283	144	479	631	479
26	90	188	144	454	709	605
27	74	188	144	454	580	529
28	74	144	235	380	529	429
29	48	105	188	429	479	504
30	48	144	188	454	479	504
31	61	144	.....	454	.....	683
Total	3,401	3,788	5,772	13,338	16,970	17,166
Mean	109.71	122.19	192.4	430.3	565.7	553.7
Run-off per square mile	0.072	0.080	0.127	0.283	0.372	0.364
Run-off in inches	0.083	0.093	0.141	0.326	0.415	0.420
Total in acre-feet	6,745.88	7,513.4	11,448.65	26,456	33,660	34,048.76

Estimated daily discharge, in second-feet, of Truckee River at Vista, Nev., for 1901.

[Observer, Sam Nelson.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	854	442	2,209	938	1,666	1,871
2	854	467	2,015	1,110	1,601	1,942
3	1,505	467	2,052	995	1,473	1,942
4	1,348	467	1,896	1,081	1,473	1,871
5	1,257	418	1,871	938	1,473	1,733
6	1,227	492	1,733	910	1,601	1,537
7	1,052	442	1,666	882	1,942	1,733
8	694	467	1,801	882	1,942	1,733
9	617	418	1,537	747	2,537	1,666
10	617	467	1,473	747	2,537	1,110
11	617	442	1,168	854	4,213	1,168
12	668	467	1,197	938	3,640	1,168
13	541	467	1,473	1,110	3,251	1,168
14	541	467	1,052	1,348	3,539	1,110
15	541	467	1,052	1,537	3,011	1,052
16	467	1,537	1,081	1,634	3,165	967
17	442	2,385	967	1,634	2,537	967
18	418	1,871	967	1,666	2,168	967
19	418	1,871	995	1,733	2,168	1,197
20	467	1,906	938	1,942	2,168	1,110
21	541	3,748	1,052	1,733	2,090	1,024
22	541	4,213	1,081	1,871	1,666	1,110
23	442	2,780	1,287	1,733	1,537	1,110
24	442	2,652	1,110	1,733	1,410	1,024
25	516	2,780	1,168	1,733	1,410	854
26	492	3,079	1,227	1,942	1,410	854
27	418	2,922	1,110	1,871	1,442	1,024
28	467	3,079	1,081	1,733	1,871	967
29	541	.....	995	1,801	1,906	910
30	516	.....	967	1,634	1,906	995
31	442	.....	995	.....	1,733	.....
Total	20,503	41,680	41,156	41,410	66,486	37,884
Mean	661	1,486	1,328	1,380	2,145	1,263
Run-off per square mile	0.435	0.978	0.874	0.908	1.412	0.831
Run-off in inches	0.502	1.019	1.008	1.014	1.628	0.928
Total in acre-feet	40,644	82,529	81,657	82,117	131,894	75,155

Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	910	207	274	418	566	720
2	995	185	322	418	566	720
3	668	251	322	418	566	773
4	720	274	322	467	566	882
5	747	492	322	442	566	1,287
6	694	418	322	467	566	720
7	516	346	322	442	566	566
8	492	370	298	467	516	566
9	492	274	322	418	516	566
10	541	228	298	442	516	566
11	492	146	298	566	516	566
12	643	185	274	516	516	418
13	566	251	274	467	516	418
14	467	346	274	442	516	467
15	370	128	251	418	541	442
16	370	492	274	467	516	418
17	346	492	346	442	541	370
18	394	492	274	467	516	370
19	346	492	274	442	516	370
20	346	492	274	467	541	418
21	146	346	274	467	541	418
22	166	346	274	370	541	418
23	166	346	274	370	541	442
24	185	322	467	418	467	370
25	185	322	467	467	541	370
26	185	228	467	467	617	370
27	228	251	467	492	541	370
28	185	298	418	720	566	370
29	228	251	418	668	882	418
30	207	228	418	643	720	418
31	185	274	.....	617	.....	322
Total	13,181	9,773	9,881	14,792	16,702	15,809
Mean	425	315	329	477	557	510
Run-off per square mile	0.323	0.227	0.242	0.362	0.409	0.387
Run-off in inches	0.280	0.207	0.217	0.314	0.367	0.336
Total in acre-feet	26,133	19,369	19,577	29,330	33,144	31,357

The observations have not extended over a sufficient period to show the mean flow of the streams, but the data are of special value, for, having been collected during extremely dry seasons (the years 1898, 1899, and 1900 were years of exceedingly small water supply on Truckee River), they show very nearly the minimum run-off from the watersheds.

The discharge measurements at Vista, taken in connection with those at Stateline Mills and with the measurements of the irrigating ditches which have been made during the season of 1900, with the knowledge that during August and part of September, 1899, and a considerable portion of July and August, 1900, the entire flow of Truckee River was being diverted above, furnish a basis for estimating the volume of the seepage or return water from irrigation in the Reno Valley.

Besides the measurements and observations made at the regular stations mentioned, the results of which are given in the foregoing tables, a number of measurements of the principal tributaries of Truckee River were made with a view to estimating the relative run-off from different portions of the basin. The results of these measurements, in order downstream, are as follows:

Discharge measurements of tributaries of Truckee River.

Date.	Stream.	Point of measurement.	Discharge.
1900.			*Sec.-ft.*
June 16	Deer Creek		25.19
June 5	Squaw Creek		81.39
June 16	do		46.01
September 14	do		2.76
May 16	Donner Creek	Near Donner Lake	127.8
May 29	do	do	73.42
July 13	do	do	1.09
August 20	do	do	69.00
September 13	do	do	19.19
May 21	do	Near Truckee River	324.48
June 3	do	do	126.97
June 12	do	do	98.89
July 13	do	do	14.69
September 13	Cold Creek		1.35
May 21	Martis Creek		24.51
June 4	do		17.52
September 14	do		8.54
June 3	Truckee River	One-half mile below Truckee	364.00
June 12	do	do	264.00
June 4	Prosser Creek	At mouth	145.112
July 27	do		24.67
September 9	do		9.54
May 19	Little Truckee River	At Boca	*a* 600.00
June 6	do	do	492.00
August 16	do	do	8.94
September 15	do	do	27.14
June 6	Juniper Creek		*a* 30.00
September 15	do		1.33
May 19	Joe Gray Creek		*a* 30.00
July 28	do		20.28
September 15	do		12.28
May 19	Alder Creek		*a* 30.00
July 25	do		12.63
September 10	do		10.29
July 26	Dog Valley Creek		0.40
September 10	do		0.79
June 7	Hunter Creek		40.7
September 12	do		5.93

a Estimated.

TRUCKEE RIVER AT RENO, NEV., DURING LOW WATER IN JULY, 1902.

In the early part of May, 1900, measurements were also made of the principal streams flowing into Lake Tahoe, with results as follows:

Discharge measurements of streams flowing into Lake Tahoe.

Date.	Stream.	Discharge.
1900.		*Sec.-ft.*
May 5	Ward Creek	147
May 6	Blackwood Creek	140
Do	Three small streams between Idlewild and McKinneys	*a* 12
Do	McKinney Creek	105
May 7	General Creek	100
Do	Meiggs Creek	130
May 7-8	Five small streams between Meiggs Creek and Emerald Bay	*a* 12
May 8	Emerald Bay Creek	60
Do	Cascade Creek	30
Do	Taylor Creek	160
May 9	Upper Truckee River	350
May 10	Ten small streams between Bijou and Glenbrook in Nevada	*a* 15

a Estimated.

Owing to severe wind storms, making it impossible to go on the lake in a small boat, it was not practicable to measure the streams entering from the east and north between Glenbrook and Tahoe, though some of them were discharging considerable water.

During August and September, 1901, another series of measurements of the various streams emptying into the lake was made, with the object of checking as closely as practicable the measured evaporation from the lake surface. Following are the results of these measurements, beginning with the first stream south of the lake outlet and following in regular order around the lake from right to left:

Discharge measurements of streams flowing into Lake Tahoe.

Date.	Stream.	Discharge.	Date.	Stream.	Discharge.
1901.		*Sec.-ft.*	1901.		*Sec.-ft.*
August 19	Ward Creek	3.20	September 10	Unnamed creek	*a* 0.15
September 8	do	1.72	August 23	do	*a* 0.20
August 19	Blackwood Creek	3.91	September 10	do	*a* 0.20
September 8	do	2.99	August 23	do	*a* 0.20
August 20	McKinney Creek	0.89	September 10	do	*a* 0.15
September 8	do	0.65	August 24	Glenbrook Creek	0.38
August 21	General Creek	1.50	September 10	do	0.40
September 8	do	1.08	Do	Spooner Creek	0.91
August 21	Meiggs Creek	1.29	Do	Unnamed creek	*a* 0.80
September 8	do	*a* 0.04	August 27	do	0.71
August 21	Unnamed creek	0.85	September 11	do	*a* 0.50
September 8	do	0.42	August 27	do	2.00
August 22	Rubicon Creek	2.23	September 11	do	2.46
September 8	do	1.90	August 27	do	2.80
August 22	Unnamed creek	*a* 0.50	September 11	do	2.54
September 9	do	*a* 0.40	August 27	do	*a* 0.20
August 22	Emerald Creek	5.76	September 11	do	*a* 0.20
September 9	do	1.24	August 27	do	1.52
August 22	Cascade Creek	2.37	September 11	do	1.04
September 9	do	0.80	August 27	do	1.14
August 22	Taylor Creek	8.64	September 11	do	0.53
September 9	do	3.33	August 27	do	*a* 0.60
August 22	Upper Truckee River	47.12	September 11	do	*a* 0.40
September 9	do	35.14	August 26	Hot Springs Creek	1.96
August 22	Trout Creek	32.76	September 11	do	1.26
September 9	do	23.37	August 25	Unnamed creek	*a* 0.20
August 23	Unnamed creek	*a* 0.10	September 7	do	*a* 0.20
September 10	do	*a* 0.06	August 25	do	1.34
August 23	do	*a* 0.20	September 5	do	0.82

a Estimated.

EVAPORATION.

Evaporation has received less attention than any other subject bearing upon water supply in the West, and as a consequence it is a factor of great uncertainty.

On May 17, 1900, a galvanized-iron tank 2 feet square and 2 feet in depth was placed in Lake Tahoe at its outlet, where it was protected from the heavy waves of the lake, for the purpose of measuring the evaporation from the lake surface. A finely divided scale was placed in the tank, and daily readings were taken about the same hour each day by Mr. J. U. Haley, general freight and passenger agent of the Lake Tahoe Railway and Transportation Company. The tank was at all times kept filled to within 1 or 2 inches of the top, and was floated by means of a timber frame, which also served as a protection from waves and drift, so that the water level inside and outside was about the same. The depth of water in which the tank was anchored was about 6 feet, and the water in the tank was fully exposed to wind and sun. The following table gives the monthly evaporation from May 17, 1900, to December 31, 1901, with the exception of the month of July of the latter year, when no record was kept, the tank having been damaged:

Evaporation in Lake Tahoe at Tahoe, Cal.

Month.	1900.	1901.	Month.	1900.	1901.
	Inches.	*Inches.*		*Inches.*	*Inches.*
January		0.84	July	4.00	(a)
February		0.70	August	5.15	6.50
March		0.77	September	3.10	4.12
April		1.25	October	2.15	2.65
May 17 to 31	1.83	2.42	November	1.38	2.09
June	3.80	3.35	December	1.33	1.44

a No record.

As has been stated, during a portion of the months of August and September, 1901 (from August 19 to September 18, inclusive), a series of measurements of all of the streams discharging into Lake Tahoe was undertaken, with a view to checking the evaporation records kept at Tahoe. Two measurements were made of each stream. At the same time a careful record of the outflow from the lake was kept and daily observations of evaporation were made.

For the purpose of approximating the mean discharge of the various affluents during that period the mean of the two measurements of each stream was taken, this being deemed proper under the conditions, and the sum of the means was assumed to be the mean daily inflow to the lake. The following table gives the results of this study:

Results of hydrographic investigations at Lake Tahoe from August 19 to September 18, inclusive, 1901.

Inflow:		
Mean daily discharge of streams into lake	second-feet	106.04
Total addition to lake supply	acre-feet	6,310
Equivalent depth on lake surface	inches	0.606
Outflow:		
Mean daily discharge through Truckee River	second-feet	356.68
Total outflow from lake	acre-feet	21,931
Equivalent depth on lake surface	inches	2.105
Net outflow:		
Total outflow less total inflow	acre-feet	15,621
Equivalent depth on lake surface	inches	1.50
Total measured evaporation	do	5.71
Net reduction of lake level	do	7.21
Observed reduction of lake level, fixed gage	do	7.20

During the period over which these observations extended there were no rains which could interfere with their accuracy. It is therefore believed that the observed evaporation at Lake Tahoe since May 17, 1900, will very closely approximate the actual loss from the lake surface from that source, as well as the probable evaporation in other lakes or in storage reservoirs situated at about 6,000 feet altitude in this portion of the Sierras during the period over which the record extends. Of course, evaporation is not constant from year to year, but the variation should not be great in this region, and as the summer of 1900 and the summer and fall of 1901 were unusually dry and windy, the evaporation during that period can probably safely be considered a maximum.

During the year 1894, from May 11 to November 30, the writer conducted a series of observations at Reno, Nev., with a view to determining approximately the depth of evaporation at that place. For this purpose a small galvanized-iron tank, 18 inches square and 18 inches deep, was sunk in the ground until the rim was but half an inch above the surface. This was at all times kept filled to within less than 1 inch of the top, and was so placed that it was fully exposed to sun and wind. The earth immediately around the tank was kept wet. The results are believed to be a fairly close approximation to the loss that would occur in a lake, reservoir, or canal at Reno; and since the conditions influencing evaporation—temperature, humidity of atmosphere, winds, etc.—over the lower portion of Truckee Basin are nearly identical with those at Reno, they should be roughly applicable to other points in that portion of the basin. In estimating the evaporation from proposed storage reservoirs or canals, however, conservative judgment would dictate the addition of a liberal percentage for safety, especially since the results are for only a part of one season.

Evaporation from tank in earth at Reno, Nev., during 1894.

	Depth in inches.
May 11 to 31	2.80
June	5.35
July	8.45
August	9.12
September	7.44
October	4.31
November	2.75
Total	40.22

If the evaporation during the remaining five months of the year amounts to 12.78 inches in depth, or an average of about 2½ inches a month, which would appear from the foregoing table to be a fair estimate, the total for the year would amount to 53 inches.

It is possible that the evaporation from the surface of Pyramid and Winnemucca lakes may be a trifle greater than this, though a comparison of the following data with the results of discharge measurements of Truckee River at Vista, remembering that the run-off from the portion of the drainage area below that place is merely nominal and that the precipitation at the lakes is probably less than 6 inches, would indicate the reverse.

Estimated evaporation from Pyramid and Winnemucca lakes, based on observations at Reno, Nev., in 1894.

Depth of annual evaporation	inches	53
Combined area of lakes	square miles	345
Total evaporation	acre-feet	975,200

To compensate for this loss and maintain the water-surface level in the lakes would require a mean annual inflow of 1,347 cubic feet per second.

Comparison with the results of measurements given in the table of estimated mean monthly, annual, and mean annual discharge of Truckee River at Vista (pages 22–23) would indicate that the mean annual evaporation is less than the foregoing estimate, or that the normal run-off from the Truckee Basin is greater than indicated in the table referred to.

INVESTIGATIONS OF 1889 AND 1890.

RESERVOIR SITES.

During the years 1889 and 1890 surveys were made to ascertain the most feasible and economical mode of utilizing the waters of Truckee River, and the results of the field examinations were reported upon by Mr William Ham. Hall, supervising engineer.[1] Surveys were made

[1] Eleventh and Twelfth Ann. Repts. U. S. Geol. Survey, Pt. II, and Thirteenth Ann. Rept., Pt. III.

of the reservoir sites enumerated in the table on page 38, and the reports included a discussion of the mode of diverting and utilizing the waters.

Two projects for the utilization of the waters of Lake Tahoe were investigated. The first contemplated driving a tunnel through the Tahoe Range from what is known as Boundary Bay, in the southeastern part of the lake, near the Nevada-California boundary line, to Haines Creek Canyon, on the west side of Carson Valley, a distance of 17,331 feet, and tapping the lake 20 feet below the low-water plane. The second project had in view the construction of a dam in the lake outlet at Tahoe, for the purpose of raising the lake surface and drawing off the surplus water through Truckee River for use along that stream.

Two projects for water storage in the Donner Lake basin were also considered and estimated upon. One of these provided for storage in the lake alone, by means of raising, and closing a gap in, an ancient glacial moraine immediately below and to the east of the lake, thus raising its surface 20 feet above low-water plane and impounding 22,205 acre-feet of water, the surface area of the reservoir being 1,337 acres. The other contemplated the construction of two dams, 98 and 33 feet in height, respectively, and impounding the waters of the Donner Lake and the Cold Creek basins. This reservoir would have a surface area of 2,006 acres and a storage capacity of 42,827 acre-feet. The cost of the first project was estimated at $54,810 and of the second project at $279,245. No provision was made in these estimates for cost of rights of way and damages to property, which in the case of the second and larger reservoir would be very great, as the track of the Central Pacific Railroad would have to be removed for a considerable distance.

At Independence Lake it was proposed to build a dam across the outlet channel about 1,800 feet below the lake, the dam to have a maximum height of 40 feet, raising the lake surface 25 feet above ordinary low water and impounding 23,707 acre-feet over a total area of 984 acres. The estimated cost of the dam alone was $56,844.

The Webber Lake reservoir was to be formed by means of a dam having a maximum height of 30 feet, estimated to cost, exclusive of rights of way and damages, $23,927, if built of earth. This dam would raise the lake level 20 feet, flooding a total area, including lake surface, of 778 acres and impounding 11,152 acre-feet.

Estimates were made of the cost of the dams for the Lower Truckee reservoirs (Nos. 1 and 2), but since they did not include rights of way and cost of moving the track of the Central Pacific Railroad, which traverses both sites, they are not quoted.

The following table gives the areas, storage capacities, and heights of dams for each of the reservoirs surveyed and reported upon:

Reservoir sites surveyed in 1889 and 1890.

Name of reservoir.	Height of dam.	Area.	Capacity.
	Feet.	*Acres.*	*Acre-feet.*
Tahoe	(a)	(a)	(a)
Donner Lake	26	1,337	22,205
Donner-Cold Creek	98 and 33	2,006	42,827
Independence Lake	40	984	23,707
Webber Lake	30	778	11,152
Squaw Valley	16	225	1,350
Truckee reservoir	70	206	(a)
Little Truckee	60	450	10,100
Stampede Valley	50	120	2,250
Twin Valley	30	310	3,480
Boca reservoir	50	350	6,500
Monument Peak	80	160	4,800
Grass Lake	30	350	4,000
Lower Truckee No. 1	50	400	7,500
Lower Truckee No. 2	60	395	7,400

a Not reported.

CANAL ROUTES.

The following canal routes were also surveyed:[1]

(1) Commencing about 20 feet below the top of the proposed Truckee reservoir dam, a little less than a mile above the town of Truckee, survey was made of a canal line on the south side of the river to command the lands extending from immediately below Truckee into Martis Valley. This line was run on a grade of 0.4 foot to 1,000 feet, and was extended 74,400 feet. No data as to the amount of land commanded are supplied, nor are any estimates of cost furnished.

(2) A canal line was surveyed from a point in the gap traversed by the wagon road to the northwest of the town of Truckee and about 2 miles east of Donner Lake, extending around to the north of Truckee, to command lands lying between Truckee River and Prosser Creek. The grade elevation of the head of this canal line was 30 feet below the proposed high-water plane of the projected Donner Lake reservoir. It was run to Prosser Creek, a distance of 29,000 feet, on a grade of 0.2 foot to 1,000 feet.

(3) Surveys were made for canals to divert water to the lands in the neighborhood of Reno, but no report of the results of these surveys was made.

(4) *Lower Truckee canals.*—Canal surveys were also made from the dam sites of the proposed Lower Truckee reservoirs (Nos. 1 and 2).[2] In each case the lines were run from points near the tops of the proposed dams. Line No. 1 was started on the south side of the river about 4¾ miles above the town of Wadsworth, and extended a total

[1] Eleventh Ann. Rept. U. S. Geol. Survey, Pt. II.
[2] Thirteenth Ann. Rept. U. S. Geol. Survey, Pt. III.

length of 50,700 feet, or to the commencement of Warm Springs Valley, 5½ miles past that town, commanding about 10,500 acres of land. Line No. 2 was started a few feet below the crest of the proposed dam for Lower Truckee reservoir No. 1, being at about 100 feet greater elevation than the head of line No. 1 and about 10½ miles above the town of Wadsworth, and was run along the mountain side south of the river to a point just above the town, thence was swung around to the south, commanding a wide valley and mesa country to the eastward. It was continued a distance of 90,000 feet, far enough to establish the fact that it could be carried into the Lower Carson or Carson Sink Valley. From the main line a branch was surveyed from just below the head of canal line No. 1, with the object of crossing Truckee River by pressure pipes. This line was carried northward, on a grade of 1 foot to the mile, a distance of 45,000 feet, to command lands on the high plateau north of Wadsworth. The main canal would command more than 100,000 acres of good land east of Wadsworth and in the Carson Sink Valley. It was given a grade of 1½ feet to the mile and a cross section of 200 square feet, making its capacity about 600 second-feet.

INVESTIGATIONS OF 1900-1901.

RESERVOIR SITES.

In the latter part of April, 1899, the writer, acting under instructions from Mr. F. H. Newell, chief of the division of hydrography of the United States Geological Survey, began a general study of the basin of Truckee River for the purpose of ascertaining its water supply and the extent to and the means by which it can be utilized for irrigation and other purposes.

Previous investigations had established the fact that in order to use the water of the Truckee to the fullest extent and the best advantage it would be necessary to construct storage reservoirs for the purpose of conserving the flood waters, thus regulating and controlling the stream flow. This was more fully demonstrated by the results of measurements made during the years 1899 and 1900, as will be seen by reference to the tables of stream measurements and discharge.

A general study of the various storage sites known to exist within the Truckee Basin was begun, with a view to ascertaining the volume of the run-off from the drainage area tributary to each and the extent to which it might economically be impounded.

In pursuing these investigations recourse was had to the precipitation data collected by the United States Signal Service and the Weather Bureau (the results being given on previous pages of this report), numerous stream measurements were made, and a number of the reservoir sites (including most of those surveyed in 1889 and 1890 and

three new ones) were examined, some of them instrumentally and others only superficially. It was not practicable, however, to give to these the careful, detailed examination requisite to supply data for working plans for the dams required, upon which final estimates of capacity and cost might be based. The estimates given are merely preliminary in character, though where doubtful they are believed to be on the side of safety.

Following is a list of the reservoirs considered worthy of construction and upon which estimates have been made:

Practicable reservoir sites in the Truckee Basin.

	Date of survey.
Lake Tahoe	1889–90 and 1900
Donner Lake	1889–90 and 1900
Independence Lake	1889–90 and 1900
Twin Valley	1889–90 and 1900
Little Truckee	1889–90 and 1900
Henness Pass Valley	1900
Dog Valley	1900

The waters which would be impounded in each of the foregoing reservoirs would be permitted to flow through their natural channels into the main Truckee River, there to be employed for the purpose of developing power for industrial uses, or to be diverted for the irrigation of the arable lands in the valleys in and adjacent to the lower portion of the Truckee Basin, where they could most economically and profitably be used.

IMPRACTICABLE SITES.

The Monument Peak and Grass Lake sites, in the Tahoe Basin, were not considered, for the reason that the waters which might be impounded there could be used only in the high, cold lake valley, where forage plants only can profitably be grown; and since, in order to convey them to the lower valleys of the Truckee Basin, they must pass through Lake Tahoe, it would be more economical to store them in the latter lake.

The Truckee reservoir, never an economical project, can no longer be considered, on account of the recent construction, through the entire length of the site, of the railroad from Truckee to Tahoe.

The site at Stampede Valley (reservoir No. 35 of the survey of 1889–90) is also partly traversed by a railroad. However, if that were not the fact, the cost of its utilization would be disproportionate to the storage capacity.

As already stated, the Lower Truckee reservoirs (Nos. 1 and 2) could not be considered, because they are traversed by the Central Pacific Railroad, which would make the cost of utilization prohibitory.

Consideration of Webber Lake as a storage site was abandoned for

the following reasons: (1) The water which would be impounded can be more economically stored in the Little Truckee and the Henness Pass Valley reservoirs, to which they are also tributary; and (2) its

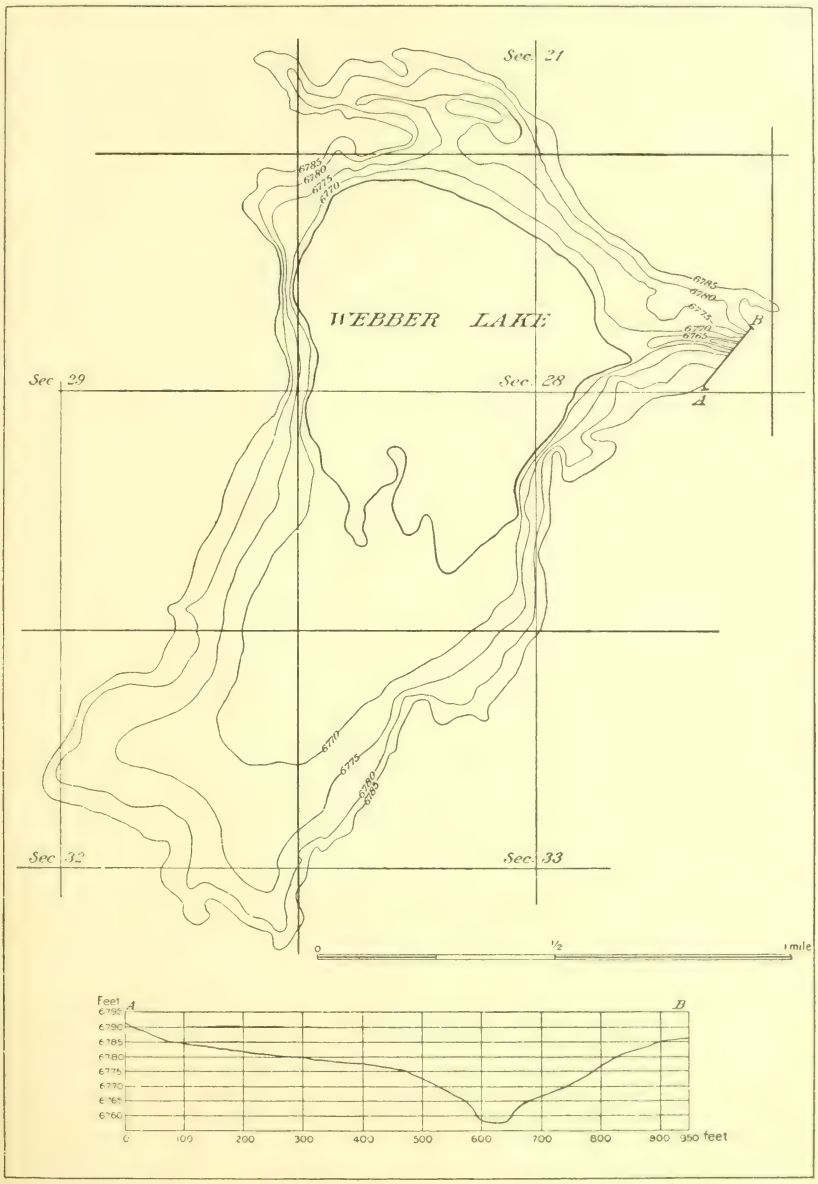


FIG. 2.—Contour map of Webber Lake and profile of dam site. The site occupies portions of secs. 21, 28, 29, 32, and 33 in T. 19 N., R. 14 E., M. D. M.

construction would involve the destruction of considerable private property, necessitating large expenses for damages, and it is deemed better, as a broad public policy, to incur expense for construction rather than destruction, especially if it be practicable to accomplish

the former without the latter. A contour map of Webber Lake and a profile of the dam site are shown in fig. 2 (p. 41).

The Squaw Valley site (see figs. 3 and 4), although calling for but

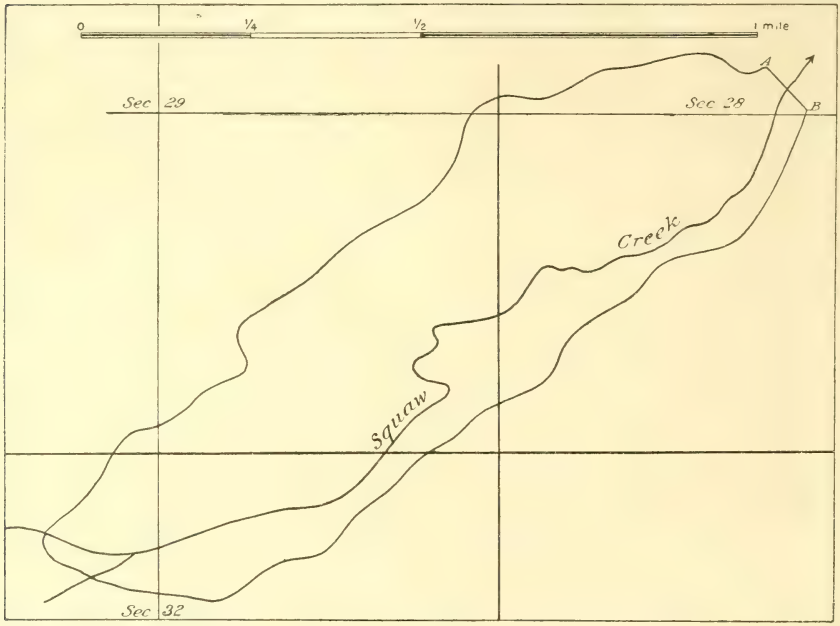


FIG. 3.—Map of Squaw Valley reservoir site. The site occupies portions of secs. 28, 29, and 32 in T. 16 N., R. 16 E., M. D. M.

a nominal outlay for construction, will, by reason of its small capacity, involve too great an expense, relatively, for watchmen, maintenance, etc., to justify its inclusion in a general water-storage project.

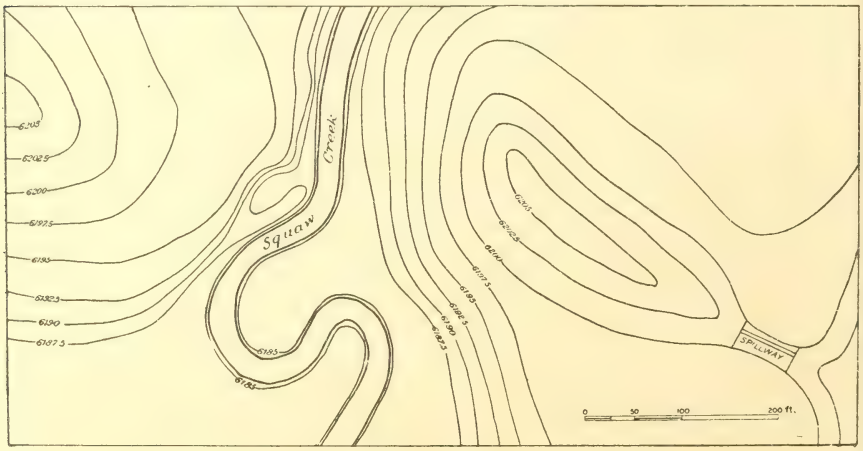


FIG. 4.—Contour map of Squaw Valley dam site.

The Boca reservoir project is abandoned on account of relatively high cost and the introduction of the silt problem, the solution of which is both difficult and expensive, and also on account of some uncertainty as to the water supply.

A. DAM IN TRUCKEE RIVER AT LAKE TAHOE.

B. VIEW LOOKING EAST FROM HEAD OF EMERALD BAY, LAKE TAHOE.

On Martis Creek, 4 miles east of the town of Truckee, is a site with an ample water supply, but examination has demonstrated that it would be too expensive in proportion to its storage capacity.

In Little Valley, to the west of Washoe Lake and immediately east of the crest of the Tahoe mountain range, is a very good site, having a capacity of about 6,500 acre-feet, where the cost of construction would not be great. However, the water stored would be employed only to increase, and insure in dry seasons, the supply for lands now under irrigation in the Washoe Valley, and would have no bearing upon the general project of reclamation of arid lands in the Truckee Basin.

At Sardine Valley, about 9 miles north of Boca, in the basin of Little Truckee River, is a very good reservoir site, where about 16,000 acre-feet of water could be stored, but unfortunately a railroad has recently been built through it, and the cost of its removal would be greater than the value of the water for many years to come.

LAKE TAHOE.

Lake Tahoe (shown in Pl. I and in fig. 5) is the greatest natural lake of the Sierra Nevada and one of the largest mountain lakes in America. Its maximum length from north to south is 21½ miles and its extreme width from east to west 12 miles. Its area is 193 square miles and its altitude above sea level about 6,225 feet at mean low stage. Its greatest depth is about 2,000 feet. The tributary watershed, including its own surface and excluding the drainage area of Marlette Lake, whose waters are diverted from the basin for the supply of Virginia, Nev., is 519 square miles. Its natural outlet is Truckee River, which leaves the lake at Tahoe.

The boundary line between the States of California and Nevada passes through the lake, leaving about two-thirds of its area in the former State and one-third in the latter State. With the exception of Lake Valley, at its southern end, almost the entire watershed is composed of rugged, precipitous mountains, which rise from 1,500 to 4,700 feet above its surface and generally descend abruptly to the water's edge. Originally these mountains were densely timbered, but during recent years those to the east of the lake have been almost denuded of their forests for lumber and fuel.

In the channel of Truckee River, about 500 feet back from the lake, is a crib dam of timber and stone (see Pl. IV, *A*), which for the last twenty years or more has been controlled by the Truckee Lumber Company, which has used the lake waters for flushing logs down the river and for supplying power to its sawmills at Truckee when the natural flow of the stream is insufficient for those purposes. For the last five years the waters have not been employed for flushing logs, but they are still used for power purposes. The dam has three openings, with 10.7, 10.5, and 9.3 feet clear width, which are closed

by timber gates. The two wider openings have in the center vertical posts 8 inches in width, which have been deducted in the

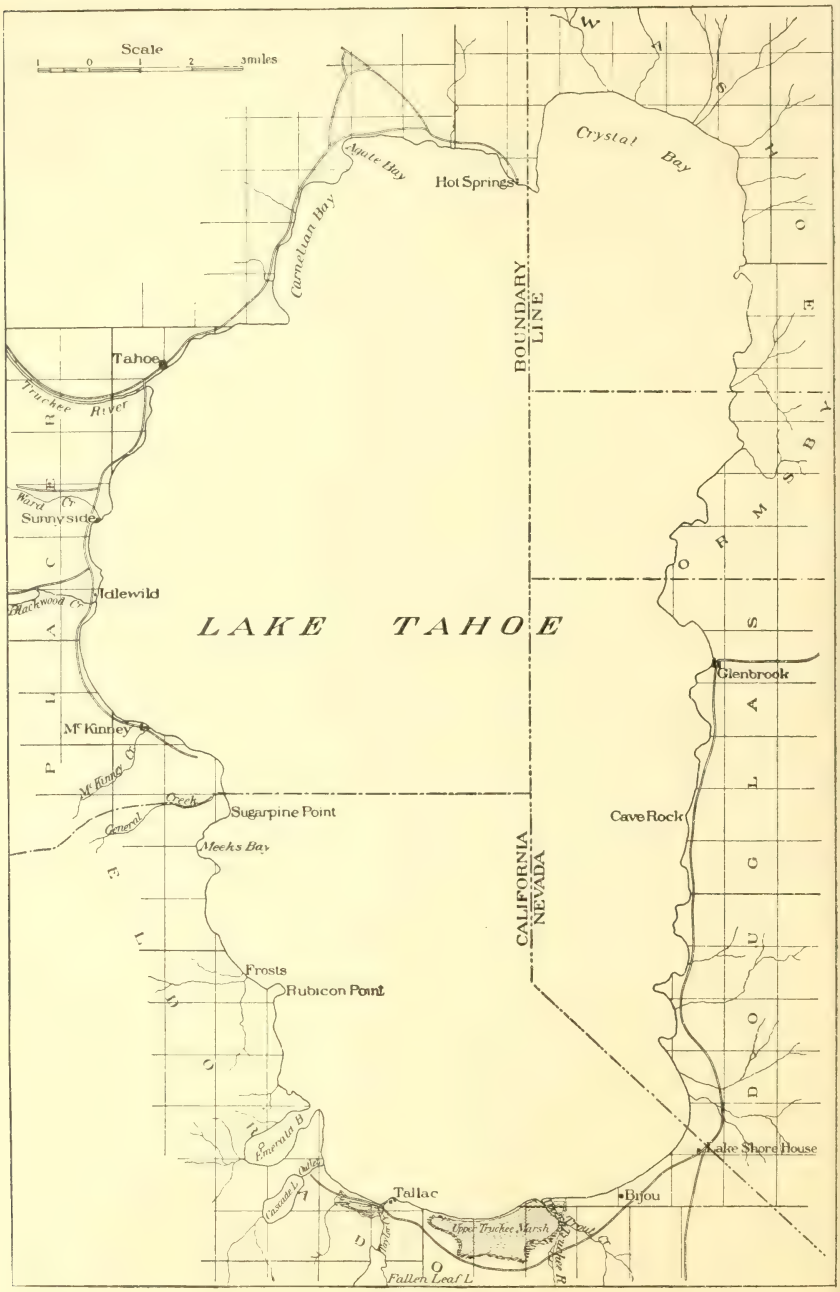


FIG. 5.—Map of Lake Tahoe.

widths of the openings given. The dam has a waste way of 72 feet clear length and 6 feet above the floor of the gates.

The following data regarding the fluctuations in the lake's surface are taken from the Eleventh Annual Report of the United States Geological Survey, Part II. On July 19, 1889, the elevation of the lake surface was taken at 6,225 feet. As subsequently found, the water afterwards fell during that summer about 1.2 feet, reaching extreme low water in the autumn. At the time of the survey, July 19, the wasteway crest was 5.05 feet above the water surface of the lake. As afterwards ascertained by Mr. William Ham. Hall, supervising engineer of the United States Irrigation Survey, the lowest known water plane of the lake was in October, 1889, when, as already stated, the surface was about 1.2 feet lower than at the time of the survey. The highest observed elevation of the lake's waters at Tahoe occurred in the spring of 1886, and was from 5.3 to 5.5 feet above the extreme low water of 1889. The high water of 1888 was observed on September 8, 1.85 feet, and that of 1889 in the early spring of that year, 1.55 feet above the same datum. The high water of the spring of 1890 was very nearly as great as that of 1886, notwithstanding the fact that the outlet gates of the dam remained open during the rising period.

From 1890 to 1895 no data of the fluctuations of the lake level are obtainable, but on July 3 of the latter year the writer began a series of observations of the outflow from the lake. At that time the water surface in the lake was 5.95 feet higher than the above datum. The outlet gates then and for a considerable time previously were open and more than 1,100 cubic feet per second were flowing out. The maximum stage was reached on July 7, when the water stood at 5.97 feet, but on July 11 it began to recede, reaching the lowest point on December 17, when it was 4.5 feet. On February 29, 1896, when observations were discontinued, the water stood 4.98 feet higher than the datum mentioned. From that time until April 28, 1900, no reliable record of the variations in the lake level was kept. On the latter date the writer began the investigations described herein, and found that the water level was then 3.30 feet above the extreme low-water level of 1899, or 3.05 feet above the floor of the outlet gates in the dam at the lake outlet. The water continued to rise gradually until June 17, when the outlet gates were first opened, having then reached a height of 3.95 feet. After that date it remained stationary until July 1, when it began to fall gradually, until on October 17 it was 2.82 feet. After that time, until November 30, it fluctuated between 2.82 and 2.98 feet, standing at 2.95 feet on the latter date. From November 30, 1900, to July 27, 1901, only occasional observations were made. On the latter date the water in the lake reached the highest stage during the year—5.38 feet above extreme low water of 1889, or 5.13 feet above the floor of the outlet gates. From July 27 until August 4 the water level remained stationary, but on the latter date it began to decline, reaching the lowest stage on November 30, when it was 3.86 feet above the floor of the outlet gates. During December it rose as high as 4.06 feet, but on the last day of that month it stood at 3.98 feet.

The following table shows the height of the lake surface above the floor of the outlet gates in the dam as observed daily from April 28 to November 30, 1900, and at intervals from that date until December 31, 1901.

Observed heights of water surface in Lake Tahoe above floor of outlet gates.

1900.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov
1	.....	3.09	3.54	3.70	3.39	2.89	2.63	2.61
2	.....	3.10	3.55	3.69	3.38	2.88	2.62	2.61
3	.....	3.11	3.56	3.67	3.36	2.87	2.62	2.61
4	.....	3.15	3.57	3.67	3.34	2.90	2.63	2.60
5	.....	3.16	3.58	3.66	3.33	2.90	2.64	2.60
6	.....	3.17	3.59	3.65	3.32	2.89	2.65	2.60
7	.....	3.18	3.60	3.64	3.30	2.88	2.64	2.59
8	.....	3.19	3.61	3.63	3.28	2.87	2.64	2.64
9	.....	3.20	3.62	3.61	3.27	2.86	2.63	2.64
10	.....	3.22	3.63	3.60	3.25	2.84	2.62	2.65
11	.....	3.24	3.64	3.59	3.24	2.83	2.61	2.65
12	.....	3.26	3.65	3.58	3.22	2.82	2.60	2.65
13	.....	3.28	3.66	3.59	3.20	2.81	2.60	2.65
14	.....	3.30	3.68	3.58	3.19	2.80	2.59	2.64
15	.....	3.32	3.69	3.57	3.17	2.78	2.58	2.64
16	.....	3.34	3.69	3.55	3.15	2.77	2.58	2.64
17	.....	3.36	3.70	3.55	3.13	2.76	2.57	2.69
18	.....	3.37	3.70	3.54	3.11	2.75	2.57	2.70
19	.....	3.39	3.70	3.53	3.10	2.74	2.63	2.69
20	.....	3.40	3.70	3.52	3.08	2.73	2.63	2.70
21	.....	3.41	3.70	3.51	3.07	2.72	2.63	2.72
22	.....	3.43	3.70	3.50	3.05	2.71	2.62	2.73
23	.....	3.44	3.70	3.49	3.03	2.69	2.61	2.73
24	.....	3.45	3.70	3.48	3.02	2.68	2.61	2.72
25	.....	3.46	3.70	3.47	3.00	2.67	2.60	2.71
26	.....	3.47	3.70	3.46	2.98	2.67	2.59	2.72
27	.....	3.48	3.70	3.45	2.96	2.66	2.59	2.72
28	3.05	3.49	3.70	3.44	2.94	2.65	2.62	2.71
29	3.06	3.51	3.70	3.43	2.93	2.64	2.62	2.71
30	3.07	3.52	3.70	3.42	2.91	2.63	2.61	2.70
31	.....	3.53	.....	3.41	2.90	.....	2.61	.....

1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	2.88	.....	.....	.....	.....	.....	5.13	4.81	.....	.....	.....
2	.....	.....	.....	.....	.....	.....	.....	5.13	4.79	.....	.....	.....
3	.....	2.88	.....	.....	.....	.....	.....	5.13	4.76	.....	.....	.....
4	.....	.....	.....	.....	.....	.....	5.05	5.13	4.74	.....	.....	.....
5	.....	.....	3.70	.....	.....	.....	.....	5.12	4.71	.....	.....	.....
6	.....	.....	.....	3.90	.....	.....	.....	5.12	4.68	.....	.....	4.06
7	.....	.....	.....	3.90	.....	.....	.....	5.12	4.66	.....	.....	4.05
8	.....	.....	.....	.....	.....	.....	.....	5.12	4.63	.....	.....	.....
9	.....	3.07	.....	.....	.....	.....	.....	5.12	4.61	.....	.....	4.03
10	.....	.....	.....	.....	.....	.....	.....	5.12	4.59	.....	.....	4.02
11	.....	.....	.....	.....	.....	.....	.....	5.12	4.56	.....	.....	.....
12	.....	.....	.....	.....	.....	.....	.....	5.12	4.55	.....	4.04	.....
13	.....	.....	.....	3.90	.....	.....	.....	5.11	4.53	.....	.....	4.00
14	.....	.....	.....	.....	.....	.....	.....	5.11	4.51	.....	4.03	.....
15	.....	.....	.....	.....	.....	.....	.....	5.11	4.51	.....	.....	3.98
16	.....	.....	.....	.....	.....	.....	.....	5.11	4.51	.....	.....	.....
17	.....	.....	3.80	.....	.....	.....	.....	5.11	4.51	.....	.....	.....
18	.....	.....	.....	.....	.....	.....	.....	5.10	4.50	.....	3.98	.....
19	.....	3.47	.....	.....	.....	.....	.....	5.10	4.49	.....	.....	.....
20	2.88	.....	.....	.....	.....	.....	.....	5.09	4.47	.....	.....	.....
21	.....	.....	.....	.....	.....	.....	.....	5.07	4.46	.....	.....	.....
22	.....	.....	.....	.....	.....	.....	.....	5.05	4.45	.....	.....	.....
23	.....	.....	3.80	.....	.....	.....	.....	5.02	4.44	.....	.....	.....
24	.....	.....	.....	.....	.....	.....	.....	4.99	4.49	.....	.....	.....
25	.....	.....	.....	.....	.....	.....	.....	4.96	4.48	.....	.....	.....
26	.....	.....	.....	.....	.....	5.01	.....	4.93	4.47	.....	.....	.....
27	2.88	.....	.....	.....	.....	.....	5.13	4.91	4.46	.....	.....	.....
28	.....	3.65	.....	.....	.....	.....	5.13	4.89	4.45	.....	.....	.....
29	.....	.....	.....	.....	.....	.....	5.13	4.87	4.44	.....	.....	.....
30	.....	.....	3.80	4.10	.....	.....	5.13	4.85	4.43	.....	3.86	.....
31	.....	.....	.....	.....	4.62	.....	5.13	4.83	.....	4.20	.....	3.98

Observations of rainfall, evaporation, elevation of lake surface, and discharge should be continued at Lake Tahoe, in order that the records may be perfected and the estimates herein given be verified and checked. In considering these conditions doubtful features have been decided on the side of safety, so as to decrease the estimated supply. The estimates are therefore believed to be conservative, and it is expected that further physical studies, although deemed necessary, will demonstrate a greater and cheaper water supply.

No rainfall observations have ever been made within the Tahoe Basin, excepting those at Marlette Lake during 1894 and 1895 and at Glenbrook during the early part of 1901, and these extend over too short a time to be of much value. It is believed, however, that if the precipitation due to the elevation at the lake surface, computed from the table of increase of precipitation with each 100 feet rise, with Wadsworth as a base, or 31.97 inches, be taken as the normal for the entire Tahoe drainage area, it will be well on the side of safety. This amount of rainfall upon the lake surface will ordinarily compensate for all losses from evaporation, and the run-off from the remainder of the catchment area (326 square miles in extent), computed from the Newell curve, would be equal to a depth of 19½ inches, or 339,000 acre-feet in an average year, which can be impounded and drawn off as required.

During the seasonal year ending August 31, 1901, the mean precipitation at five stations in the upper part of the Truckee Basin was about 17 per cent in excess of the normal, though at Summit it was only 10 per cent above and at Truckee it was slightly below.

The run-off measured at Vista for the same period was only 645,112 acre-feet, being about 11 per cent less than the normal, as deduced from measurements made up to the present time, and in the writer's judgment, still below the normal run-off for the entire basin, after making allowance for the water impounded in Lake Tahoe, which would otherwise have been added to the measured run-off.[1]

During the seasonal year under consideration the volume of water discharged from Lake Tahoe through Truckee River was as follows:

Volume of water, in acre-feet, discharged from Lake Tahoe through Truckee River from September, 1900, to September, 1901.

Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Total.
11,667	9,781	8,047	4,981	6,262	4,502	1,845	565	000	1,765	13,801	25,760	88,976

On August 31, 1900, the water surface in the lake stood 2.90 feet above the floor of the outlet gates in the dam in Truckee River. On August 31, 1901, it stood 4.83 feet above, the difference being 1.93 feet, representing 241,250 acre-feet of water which had been impounded during the year. This, added to the 88,976 acre-feet discharged

[1] This conclusion is based upon the discussion of evaporation and run-off on pages 47–48.

through Truckee River, gives 330,226 acre-feet as the total run-off of the Tahoe Basin in excess of evaporation for a year when the run-off from other parts of the Truckee Basin appears from data at hand to have been somewhat below the normal. Hence it is believed that the mean annual run-off will closely approximate that estimated on page 47, or 339,000 acre-feet.

Of course the watershed will not yield this volume of water every year, but it will be seen from the figures given that frequently the run-off is greater; and by building in the lake outlet a dam of sufficient height to hold back two or three times that amount of water, which is entirely feasible, it is certain that sufficient water can be

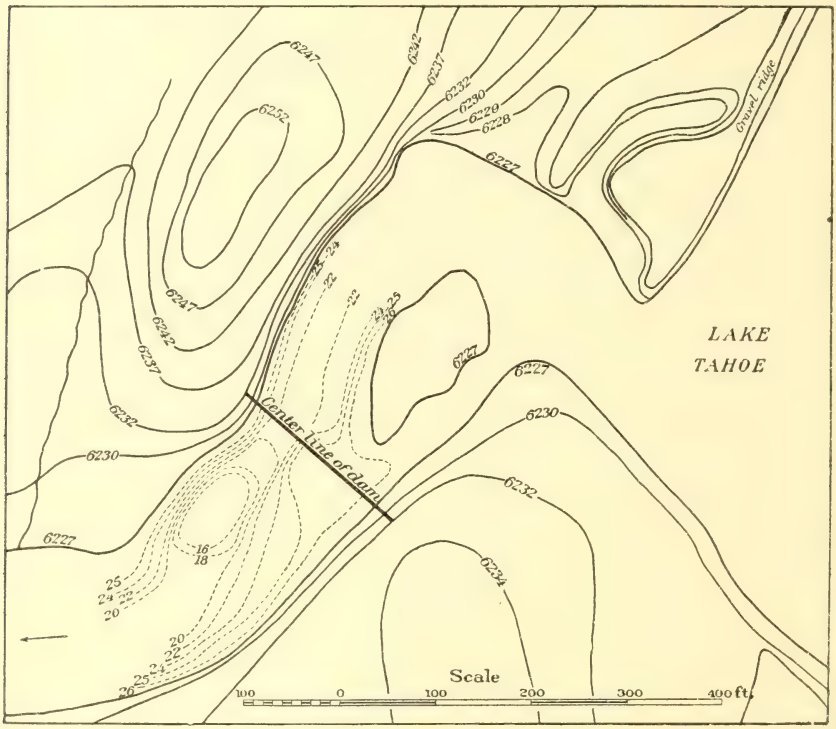


FIG. 6.—Contour map of Lake Tahoe dam site.

drawn off each season to materially augment the flow of Truckee River during low-water periods. It is estimated that fully 200,000 acre-feet can thus be drawn annually.

On making a survey of the outlet of Lake Tahoe, where the existing dam is located, it was found that the bed of the channel above this dam is in its deepest part from 1½ to 2 feet below the floor of the outlet gates, and that the general level of the ground a few feet back from the south or left bank is about 10 feet above the same datum, while the right bank rises quite abruptly to a height of 12 or 13 feet, and then more gradually for a considerable distance. This is shown in the contour map of the Tahoe dam site, fig. 6. On this map the

elevation of the floor of the outlet gates is assumed at 6,223.8 feet, and in the further discussion of this storage project that elevation is used. By reference to the map it will be seen that a dam could readily be built to a height of 8.15 feet above the floor of the outlet gates, which would raise the water to the 6,232-foot contour and yet not be excessively long nor flood a large area of land around the outlet. Investigation, however, developed the fact that if the water should be raised much above the 6,230-foot contour it would necessitate raising the many landing piers on the lake, besides doing considerable damage at several of the summer resorts upon its shores. Inasmuch, therefore, as the storage capacity at the 6,230-foot contour would be nearly 750,000 acre-feet, or almost four times the amount contemplated to be drawn off annually, which would appear to afford a sufficient reserve to tide over any dry period likely to occur, this contour has been fixed upon as the highest flow line of the proposed reservoir; and in order that the water may not be lowered to such an extent as to interfere with navigation, the 6,224-foot contour is the ultimate low-water line provided for in this report. The capacities and areas of the reservoir within these limits are estimated as follows:

Area and capacity of proposed Lake Tahoe reservoir at different elevations.

Contour.	Area.	Capacity.	Contour.	Area.	Capacity.
Feet.	*Acres.*	*Acre-feet.*	*Feet.*	*Acres.*	*Acre-feet.*
a 6,224	123,500	.....	6,228	124,700	495,600
6,226	123,700	247,200	6,230	125,100	745,400

a Level of outlet.

From the discussion of the water supply on the preceding pages it appears that two or three times in a decade there occurs a season when the drainage area yields nearly, if not quite, sufficient water to fill the reservoir, besides making up evaporation losses; while, so far as is known, there never has been a year when some water did not flow out of the lake in addition to that lost by evaporation. The precipitation tables given in the first part of this report show that at Truckee and Summit, the two stations which from their situation and surroundings should give results most nearly applicable to the Tahoe Basin, with thirty and twenty-five year records, respectively, there never have been more than two years of extremely light rainfall in succession, and never more than three in which the mean at these two stations was below the normal. This being true, it would appear reasonably safe to assume the same conditions to exist in the Tahoe watershed. It is upon this assumption and those previously stated, together with the known facts that during some years the water supply is equal to and possibly in excess of the proposed reservoir capacity and that the run-off from the drainage area is always in excess of the

losses from evaporation, that the estimate of 200,000 acre-feet available annually from a reservoir holding nearly four years' supply is based.

It may be that by impounding the water to a greater height the reservoir could be made to supply a larger amount than is here estimated, but in the absence of definite data it is not safe to rely upon it. If, however, a dam be built of sufficient height to raise the water to the 6,220-foot contour, a few years would suffice to determine the fact, and provision could then be made for the increased capacity before there would be pressing demand for the additional water.

The site selected as the most favorable one for the location of a permanent dam is a few feet above (toward the lake front) the existing dam. Here, at about the level of the lowest part of the river bed and extending across the channel, is a firm conglomerate which would afford a very good foundation. On this it is planned to erect a concrete dam having a maximum height of 13 feet and a top length of 220 feet. In this structure will be 20 gates or sluiceways, each having a clear width of 5 feet and a height of 3 feet. These will be closed by cast-iron or steel gates working on bronze bearings, which will be opened and closed by means of screw stems working in capstan head female screws at the top. No wasteway will be required in this dam, as the surplus water can at all times be drawn off through the outlet gates or can safely pass over its crest. The following estimate of cost has been prepared:

Estimate of cost of Lake Tahoe reservoir.

Dam:		
2,100 cubic yards of concrete, at $10		$21,000
Cofferdam for foundation		500
Excavation for foundation, 700 cubic yards, at $1		700
Outlet works, 20 gates complete		2,500
Deepening channel from lake to dam, distance 500 feet, excavation 5,000 cubic yards, at $0.60		3,000
Deepening channel below dam for 2,000 feet, bed width 100 feet, excavation 10,000 cubic yards, at $0.20		2,000
Damages for lands flooded:		
Upper Truckee marsh, 1,240 acres, at $4	$4,960	
Taylor Creek marsh, 110 acres, at $5	550	
Grounds at Tallac	1,250	
At Tahoe, 7½ acres, at $100	750	
		7,510
Engineering		5,000
Legal expenses		3,000
Contingencies, 10 per cent		4,521
Total		49,731

It will be seen that in this estimate provision is made for damages to lands flooded. At the southern end of the lake, at the mouth of Upper Truckee River, is a considerable area of low, marshy ground, much of which is under water at even ordinary stages of the lake,

A. DONNER LAKE.

B. FALLS OF LITTLE TRUCKEE RIVER, ONE-HALF MILE BELOW WEBBER LAKE.

but is dry at extremely low stages. A survey was made of this area, and it was found that approximately 1,240 acres lay between the 6,225-foot and the 6,230-foot contours and outside of a narrow sand bar which marks the boundary of the lake proper. The higher portions of this marsh are used for pasturage purposes in the summer and autumn. The sum of $4 an acre, or $4,960, is considered a liberal price for this land.

At the mouth of Taylor Creek, to the west of Tallac, is a similar tract of land, part marsh and part meadow, a little higher than that of the Upper Truckee, also used for pasturage. Of this area, 110 acres are below the 6,230-foot contour. A valuation of $5 an acre, which is believed to be fair, has been placed upon this land.

At Tallac about 1 acre of the improved grounds immediately adjacent to the hotel buildings is slightly below the 6,230-foot contour. The damage to this property is estimated at the cost of filling in this low ground to a height of 1 foot above the high-water line in the reservoir, which would be cheaper than moving the buildings to higher land and would really constitute an improvement of the grounds.

At Tahoe a small area of land would be flooded on each side of the lake outlet, amounting to about 7½ acres in the aggregate. That to the south is unimproved and not very valuable; part of that to the north is used by the Lake Tahoe Railway and Transportation Company. An average price of $100 an acre, or $750, which is thought reasonable, has been placed on this. In addition, $3,000 has been added to cover probable legal expenses.

DONNER LAKE.

Donner Lake, a view of which is shown in Pl. V, *A*, occupies a glacial basin lying close under the crest of the main Sierra Nevada and lengthwise between two spurs which jut eastward therefrom. Its ordinary water surface is almost 3 miles long, with a nearly uniform width of approximately a half mile, and is about 6,095 feet above sea level. It is about 3 miles west of the town of Truckee and immediately north of and below the line of the Central Pacific Railroad, where it ascends the Sierra from the east. (See fig. 7.)

The old glacial basin of Donner Lake extends eastward as a valley about 1¾ miles beyond the limits of the lake, thence its outlet is to the south, through a gap in a granite ridge, into Truckee River Valley. Cold Creek, flowing in from the south, joins Donner Creek, the lake's overflow channel, about three-fourths of a mile east of the lower end of the lake, and after flowing eastward through the valley turns to the south, through the gap mentioned, and joins Truckee River. The project for the utilization of the Donner Lake basin for a reservoir contemplates the construction of a long, low dam following an ancient terminal moraine nearly a half mile from the lower end of the lake, and impounding not only the surplus waters of the Donner

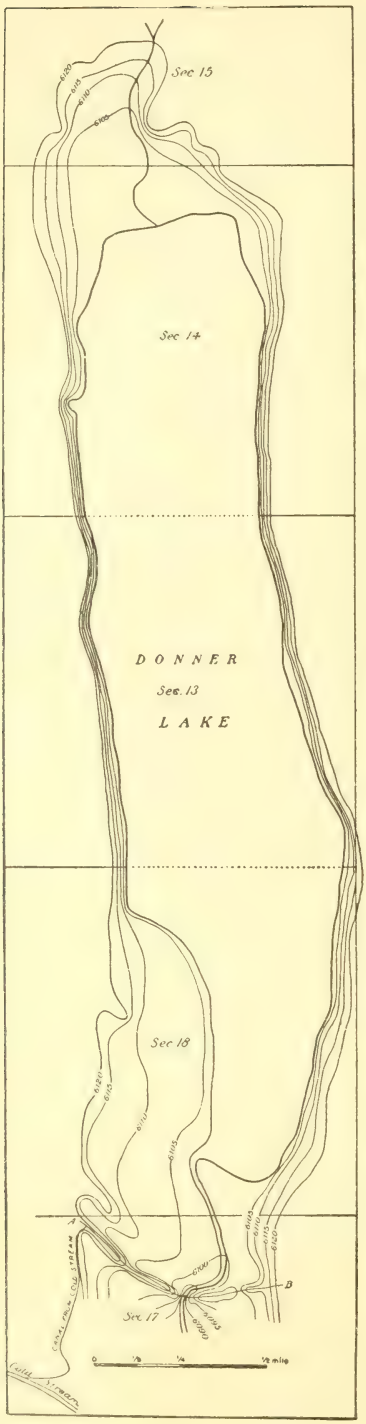


FIG. 7.—Contour map of Donner Lake reservoir site. The site occupies portions of secs. 13, 14, and 15 in T. 17 N., R. 15 E., and secs. 17 and 18, T. 17 N., R. 16 E., M. D. M.

Lake watershed, but those of the Cold Creek drainage basin also, by leading them into the reservoir by means of a canal about 3,000 feet in length. The drainage area of Donner Lake above the dam site is 14 square miles, while that of Cold Creek above where the water will be diverted to the reservoir is 13½ square miles. Several years ago Hon. Francis G. Newlands had constructed across Donner Creek, a few hundred yards below the lake, a timber dam of sufficient height to raise the water 10 or 11 feet above the low-water plane. This structure was not kept in repair, however, and it is now in condition only to retain the water to a height of 6½ or 7 feet. No continuous record of the run-off from this watershed has ever been kept, but numerous measurements of the flow of both Donner and Cold creeks were made during the years 1889 and 1900, the results of which have been given on pages 17 and 32. The measurements during the year 1889 were made after the season of high water, which occurred very early that year; hence they are not of special value, except to demonstrate the fact that the run-off from the combined Donner and Cold Creek basins during the months of July and August of the driest years is sufficient to make up all loss from evaporation, if that loss be not very much greater than was found to occur at Lake Tahoe during those months in 1900. It will be remembered that since these measurements were made below the lake, which has an area of about 840 acres, and from which evaporation was then going on,

the water there found would only be required to compensate for the loss from the increased area of the completed reservoir over that of the natural lake.

About the middle of April, 1900, the gates in the dam across the lake outlet were closed, and the water was held back until May 12, when it had risen to a height of 5½ feet above the floor of the outlet gates. On that date the gates were partly opened, and on May 16 the water surface had fallen 0.5 foot. There was then passing the gates 128 cubic feet per second. The gates were afterwards closed down somewhat, so as to maintain the water level at about the same height as on the 16th, but were not entirely closed until May 30, when the lake surface was 5.2 feet higher than the datum mentioned. The issuing stream was measured on May 29 and was found to amount to 73 second-feet. After that date the water continued to rise slowly, until on June 25 it had reached the height of 6½ feet. During that period, however, and until the gates were again opened, about August 15, there was a leakage through them of from 1 to 10 second-feet. On May 21 a measurement of the discharge of Donner Creek was made just above where it enters Truckee River, and showed 324 second-feet, of which nearly 200 second-feet were supplied by Cold Creek. On June 3 another measurement at the same point gave a result of 127 cubic feet per second, all but about 2 second-feet of which was supplied by the latter tributary; and again on June 12 the flow was 99 second-feet, practically all of which was supplied by Cold Creek. On July 13 the combined discharge of Donner and Cold creeks a short distance above the confluence with Truckee River was 15 second-feet. No additional measurements were made until August 20, after the gates in the lake outlet were opened, when the discharge, measured immediately below the dam, was 69 second-feet. On September 13 there was flowing out of Donner Lake a stream of 19 second-feet, while Cold Creek was discharging 1.35 cubic feet per second. The lake surface on that date was 3.7 feet above the floor of the outlet gates. Since Donner Lake was filled to a height of 5.5 feet, or to a capacity of more than 4,200 acre-feet, between the middle of April and the 12th of May, it is apparent that during that time the mean run-off from the watershed was at least 70 cubic feet per second, and from the known character of the Cold Creek basin it must have yielded very nearly the same amount. After May 12 and until May 30, a period of eighteen days, the combined flow of Donner and Cold creeks is estimated at an average of 280 second-feet, or a total run-off of about 10,000 acre-feet. During the month of June the average discharge of Cold Creek was about 60 second-feet, equal to 3,500 acre-feet, and about 1,300 acre-feet were impounded in Donner Lake, 250 acre-feet more escaping through the outlet dam by leakage. Thus the total amount of water yielded by the Donner and Cold Creek basins between April 15 and June 30, 1900, was approximately 23,000 acre-feet.

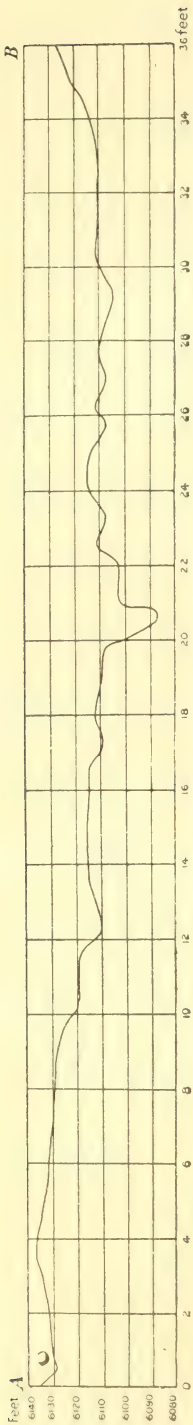


FIG. 8.—Profile of Donner Lake dam site.

While no data of the run-off in the earlier part of the year are at hand, it is certain that it was great enough to bring the total up to 28,000 or 30,000 acre-feet; and it is equally certain, as already stated, that the run-off after June 30 was ample to compensate for all loss from evaporation. Hence it has been deemed safe to plan for the storage in this basin of 26,900 acre-feet of water.

To accomplish this it will be necessary to build an earth dam or embankment along the crest of the ancient glacial moraine previously referred to, having a total length of 2,630 feet and a maximum height of 38 feet in the narrow gap through which Donner Creek flows. (See fig. 8.) The dam estimated upon would have a slope on the inner or water face of 3 horizontal to 1 vertical, and on the outer face a slope of 2 to 1, the inner slope to be paved with broken stone to protect it from the eroding action of the water, the width of the dam at its crest to be 30 feet. As previously stated, it will also be necessary to construct a canal 3,000 feet long from a point in Cold Creek nearly east of the south end of the dam, to lead the water of that stream into the reservoir.

A survey was made for this canal, and with the exception of about 200 feet of its length, where it passes around the point of the mountain and where a little rock will be encountered, it will be in earth, with nearly level cutting. The line was run on a grade of 1 to 1,000, and the canal planned to have a sectional area of 50 square feet, making the capacity 200 second-feet. For headworks all that is required is a dam or fill across the channel of Cold Creek and a waste and regulating gate near the head of the canal.

At the south end of the dam there is a favorable location for a wasteway, the width of which should be about 50 feet and the crest 6 feet below that of the dam. The outlet works estimated upon consist of two 36-inch cast-iron pipes laid side by side, incased in Portland-cement concrete and slightly curved upward at the intake end, where they will be fitted with hinged gates or valves, which will be operated from the top of the dam by means of rods working in collars set in its face.

Each pipe will also be fitted with a low-pressure screw valve at its discharge end.

The area of the Donner Lake reservoir site at different elevations above the low-water plane in the lake, given in the following table, was found by plotting the contours from the data of the surveys of 1899[1] and subsequent surveys by Mr. T. K. Stewart, a civil engineer, of Reno, Nev., and determining the area inclosed by planimeter. The lowest part of the bed of Donner Creek at the dam site is assumed to be at an elevation of 6,088 feet, and the low-water plane in the lake at 6,095 feet.

Area and capacity of proposed Donner Lake reservoir at different elevations.

Contour.	Area.	Contents.	Contour.	Area.	Contents.
Feet.	*Acres.*	*Acre-feet.*	*Feet.*	*Acres.*	*Acre-feet.*
6,095	840	0	6,115	1,260	20,400
6,105	980	9,100	6,120	1,340	26,900
6,110	1,140	14,400			

The lands which would be flooded by the construction of this dam are all private property. They are almost entirely unimproved, though at the head of the lake there is a dairy farm which is occupied during the summer, and on the north shore there is a small summer resort. The buildings of the latter, however, are small and cheap, probably costing not more than $2,500, and could readily be moved to higher ground—the shore being quite abrupt where they are situated—and the value of the resort be very slightly impaired. The existing dam at the lake outlet is also private property, but it has never been put to any beneficial private use, and has become greatly impaired since its construction. To provide for the damage to these lands and improvements the sum of $20,000 has been included in the estimate, and this provision is believed to be very liberal. The following is the estimated cost of the Donner Lake reservoir:

Estimate of cost of Donner Lake reservoir.

Dam:		
Earth embankment, 134,000 cubic yards, at $0.25		$33,500
Foundation		2,000
Riprap revetment, 14,400 square yards, at $0.65		9,360
Outlet works:		
400 feet of 36-inch cast-iron pipe, at $8.75 laid	$3,500	
200 cubic yards of concrete incasing pipe, at $8	1,600	
Valves, gates, and hoist	1,400	
		6,500
Wasteway		2,000
Supply canal from Cold Creek, complete		1,500
Damage to land and improvements		20,000
Engineering		4,000
Contingencies, 10 per cent		7,886
Total		86,746

The cost per acre-foot stored is $3.225.

[1] Thirteenth Ann. Rept. U. S. Geol. Survey, Pt. III.

INDEPENDENCE LAKE.

Independence Lake (see contour map, fig. 9) is almost an exact counterpart of Donner Lake, of glacial origin, immediately under the Sierra's crest, and held lengthwise between high, precipitous spurs projecting at right angles to it. The natural dam between these spurs, which forms the lake, is an old terminal moraine, but is not so plainly defined as that proposed to be utilized in forming the Donner Lake reservoir. It lies 9 miles, in a direct line, a little west of north from the latter lake. Its ordinary water surface is about 2½ miles in length, somewhat less than a half mile in width, and

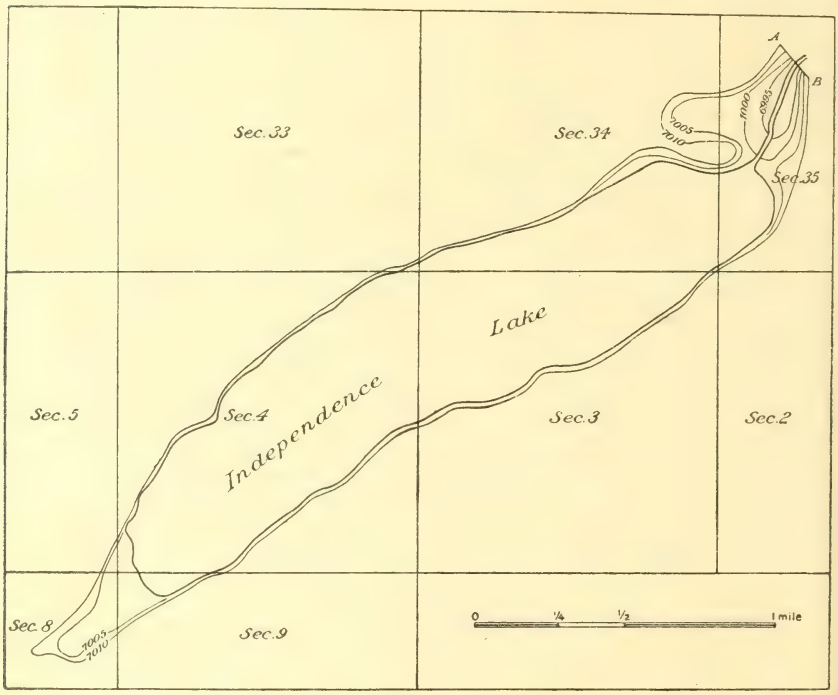


FIG. 9.—Contour map of Independence Lake reservoir site. The site occupies portions of secs. 33, 34, and 35 in T. 19 N., R. 15 E., and secs. 3, 4, 5, 8, and 9 in T. 18 N., R. 15 E., M. D. M.

covers an area of 709 acres. It is about 7,000 feet above sea level. Its waters escape through Independence Creek, flow northward, and become tributary to the Little Truckee, a main branch of Truckee River.

A survey for a storage reservoir was made at this site in 1889.[1] The dam section was chosen at a narrow part of the valley, 1,800 feet beyond the end of the lake, where the bed of the outlet creek is 12 feet below the reference water plane. (See fig. 10.) The margin of the lake and a contour 25 feet above were meandered, and a number of cross sections of the valley were measured, supplying the data

[1] Eleventh Ann. Rept. U. S. Geol. Survey, Pt. II.

from which the area and capacity of the reservoir were computed. The area embraced within the highest contour was 984 acres, and the capacity, not allowing for lowering the lake, was 23,707 acre-feet. In the autumn of 1900 this site and the drainage basin tributary to it were examined; and while the construction of a reservoir of the capacity mentioned appears feasible, and the probable cost not excessive, the water supply, except in seasons of abnormal precipitation, would not be sufficient to fill it, the catchment area, including the lake surface, being only 8½ square miles.

While no rainfall records have ever been kept in this neighborhood, the precipitation is known to be much greater than at Truckee, and probably the mean over the entire basin is greater than at Summit, on the Central Pacific Railroad. The normal at the lake-level elevation (7,000 feet), computed from the table on page 15, would be 41.89 inches. With this precipitation the annual run-off, computed from the Newell curve, would amount to 32 inches in depth, or a total of 14,500 acre-feet in volume, from 8½ square miles of watershed.

It is the common belief that the ordinary run-off from this basin is much greater, but in the absence of definite knowledge it has not been

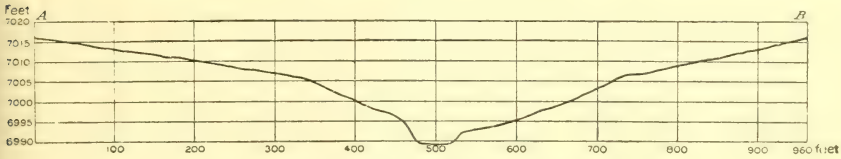


FIG. 10.—Profile of Independence Lake dam site.

deemed safe to rely upon so great a supply. Therefore a reservoir of 11,725 acre-feet capacity, contemplating raising the lake surface to a maximum height of 10 feet above the ordinary low-water plane and ultimately drawing it down to a depth of 5 feet below the same plane, has been estimated upon. To accomplish this will require the construction of a dam of 27 feet maximum height and a top length of 960 feet at the site surveyed in 1889, which appears to be the most favorable location. (See fig. 10.)

The bed of Independence Creek at this point is 12 feet below the plane of reference mentioned. To draw the water down 5 feet lower it will be necessary to excavate the channel to a depth varying from zero to 5 feet for a distance of 1,200 feet below the lake, removing about 5,000 cubic yards of earth, sand, and gravel.

The dam estimated upon is of the same type as that described for the Donner Lake reservoir, having the same slopes, a top width of 20 feet, and provided with the same type of outlet works. The material available for its construction, a loam containing a slight mixture of fine gravel and clayey matter, is plentiful near the site and can be cheaply put in place by scrapers. No investigations were made to ascertain the character of the substrata at the dam site, but the indi-

cations are that they are not such as to either endanger the stability of a dam of this type or permit the passage and loss of a volume of water that would be of consequence with the comparatively low head which will be behind the dam.

The elevation of the creek bed at the dam site has been assumed at 6,988 feet and that of the ordinary low-water level in the lake at 7,000 feet above the sea. The area of the reservoir 5 feet below the latter level is estimated. The areas embraced within the 7,005-foot and the 7,010-foot contours were determined by plotting those contours as closely as possible from the surveys of 1889 and measuring them with a planimeter. The following table gives the areas and capacities of the reservoir:

Area and capacity of proposed Independence Lake reservoir at different elevations.

Contour.	Area.	Capacity.	Contour.	Area.	Capacity.
Feet.	*Acres.*	*Acre-feet.*	*Feet.*	*Acres.*	*Acre-feet.*
6,995	700	0	7,005	820	7,500
7,000	740	3,600	7,010	870	11,725

Only about 160 acres of land, all in private ownership, outside of that occupied by the present lake would be flooded by the construction of this reservoir, and none of this is in itself of special value. Part of it is occupied by the Independence Lake summer resort, which would have to be moved to a higher and somewhat less attractive location. To defray the cost of this removal and the compensating damages, as well as the damages to lands flooded, the sum of $12,000, which is considered ample, has been included in the estimate.

Estimate of cost of Independence Lake reservoir.

Dam:		
Earth embankment, 25,600 cubic yards, at $0.25		$6,400
Foundation		1,000
Riprap revetment, 3,600 square yards, at $0.75		2,700
Outlet works:		
Excavating channel to drain lake to depth of 5 feet, 5,000 cubic yards, at $0.20	$1,000	
300 feet of 30-inch cast-iron pipe, at $8 laid	2,400	
140 cubic yards of concrete incasing pipe, at $8.50	1,190	
Valves, gates, and hoist	1,200	
		5,790
Wasteway, complete		1,000
Damage to land and summer resort		12,000
Engineering		2,000
Contingencies, 10 per cent		3,089
Total		33,979

The cost per acre-foot stored is $2.898.

TWIN VALLEY.

This reservoir site (see fig. 11) is on the North Fork of Prosser Creek, one of the main branches of Truckee River, about 4 miles, in a direct line, a little east of south of Independence Lake, and at an approximate altitude of 6,300 feet above sea level. The drainage area above the site is 12 square miles in extent, in character similar to and having about the same precipitation as the Independence Lake Basin. No measurements of discharge of the North Fork of Prosser Creek have ever been made, though during a portion of the years 1889 and 1890 the main stream was gaged immediately above its junction with

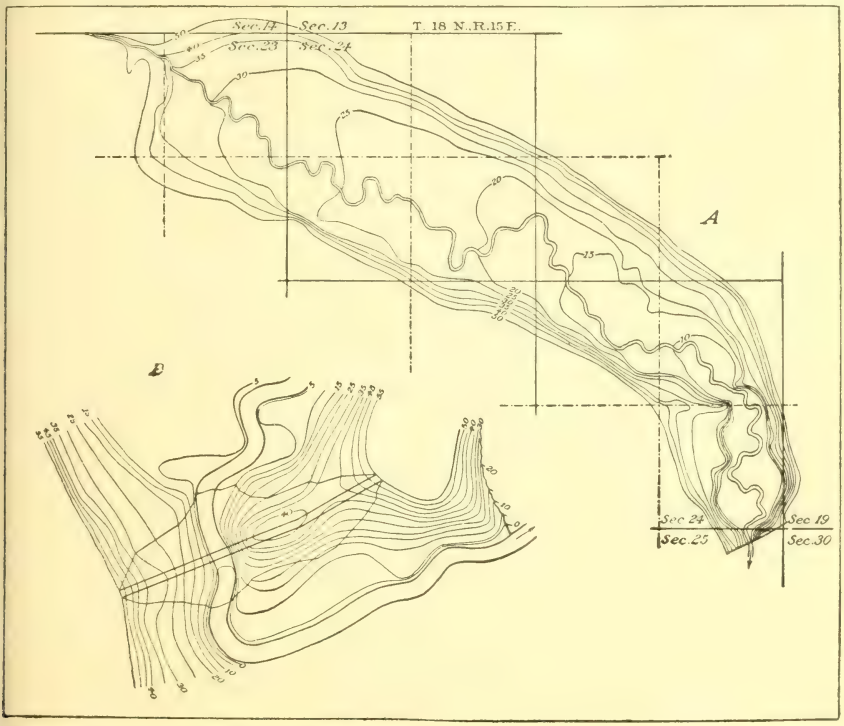


FIG. 11.—Contour maps of Twin Valley reservoir site and dam site. The site occupies portions of secs. 23 and 24 in T. 18 N., R. 15 E., M. D. M.

Truckee River, the results of the gagings being given in the tables of monthly discharge on page 21, and again in 1900 three measurements of discharge were made near the same point. However, since the reservoir planned for this location will have a capacity of but 7,818 acre-feet, there can be no question about the water supply being ample to fill it.

A survey of the reservoir site was made during the fiscal year 1889–90,[1] a cross section at the dam site being measured, a contour 30 feet above the lowest point at the dam site meandered, and several cross sections of the reservoir site surveyed to supply data for calcu-

[1] Twelfth Ann. Rept. U. S. Geol. Survey, Pt. II.

lating the capacity. It was found that the area inclosed by the 30-foot contour was 310 acres, and the contents between that contour and the base of the dam approximately 3,480 acre-feet. During the month of August, 1901, a more detailed survey of this site was made by the writer, and it was developed that water could with economy be impounded to a height of 50 feet above the lowest point in the stream bed at the dam site, or 15 feet higher than was contemplated by the original survey, the so-called 30-foot contour of that survey being really 35 feet higher than the above datum. (See fig. 11.)

The dam site is at a narrow place in the valley, which has been partially closed by an ancient glacial moraine, between which and the high granite ridge to the southwest the creek flows. It is proposed to raise this moraine somewhat and to dam the gorge now occupied by the stream by means of an earth embankment to be put in place by scrapers. The maximum height of the embankment will be 55 feet and the top length over all 760 feet. A contour map of the dam site is shown in fig. 11.

The assumed elevation of the lowest point at the dam site is 6,300 feet. The outlet gate will be at an elevation of 6,305 feet, and the high-water flow line in the reservoir at 6,350 feet. The various contours between these elevations were plotted and the areas determined by means of a planimeter. The areas and capacities are as follows:

Area and capacity of Twin Valley reservoir site at different elevations.

Contour.	Area.	Capacity.	Contour.	Area.	Capacity.
Feet.	*Acres.*	*Acre-feet.*	*Feet.*	*Acres.*	*Acre-feet.*
6,305	3	0	6,330	221	2,105
6,310	23	65	6,335	266	3,323
6,315	50	248	6,340	292	4,718
6,320	85	585	6,350	328	7,818
6,325	151	1,175			

The dam estimated upon is of the same type as that described for the Donner Lake and the Independence Lake reservoirs, with the same slopes and a top width of 20 feet. Material for its construction, of fair quality, is to be found in the valley above, the average haul being about 1,000 feet. As designed, the outlet works will consist of a tunnel through the glacial moraine referred to, about 225 feet east of the creek bed, in which will be laid a single 30-inch cast-iron pipe encased in Portland-cement concrete and surrounded by proper cut-off rings of the same material. To this pipe will be fitted valves and gates similar to those described for the Donner Lake reservoir outlet. The wasteway will be located at the north end of the dam. It will consist of a concrete weir with a wooden discharge flume lined with sheet iron, to convey the water to the creek channel below the dam.

The lands which will be flooded by this reservoir are all in private ownership, and nearly all are excellent pasture lands, though they can be used for this purpose only in summer time. The only improve-

ments upon them consist of a small frame dwelling and a dairy house of very cheap construction. The sum of $3,200 has been allowed in the estimate for right of way over flooded lands and damages to improvements. Following is the estimate of cost:

Estimate of cost of Twin Valley reservoir.

Dam:		
Preparing foundation		$1,000
Earth embankment, 72,000 cubic yards, at $0.25		18,000
Riprap revetment, 7,800 square yards, at $0.50		3,900
Outlet works:		
250-foot tunnel with approaches	$1,250	
260 feet of 30-inch cast-iron pipe, at $8, laid	2,080	
Concrete encasing pipe, cut-off walls, and tunnel portals, 160 cubic yards, at $0.10	1,600	
Valve, gate, and hoist	820	
		5,750
Wasteway, complete		2,600
Right of way over flooded lands and damages		3,200
Engineering		3,000
Contingencies, 10 per cent		3,745
Total		41,195

Cost per acre-foot, stored, is $5.27.

LITTLE TRUCKEE.

This reservoir site, surveyed during the season 1889–90 and designated reservoir No. 34[1], is on Little Truckee River, between Webber

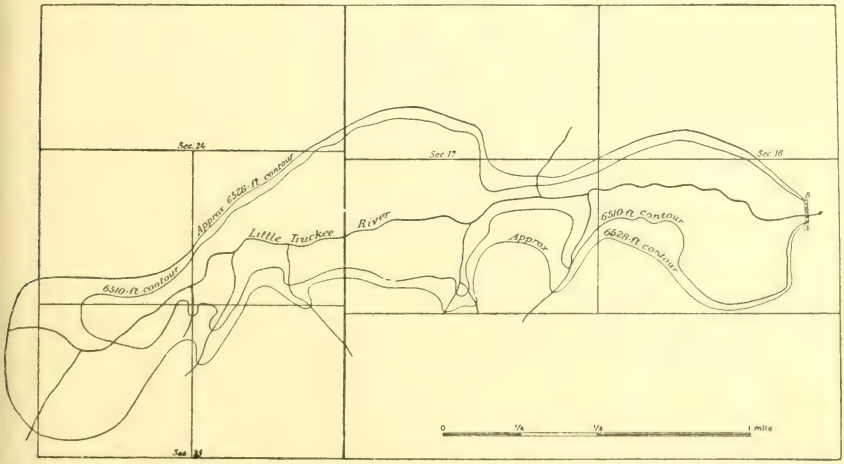


FIG. 12.—Contour map of Little Truckee reservoir site No. 1, in secs. 24 and 25, T. 19 N., R. 14 E., and secs. 16 and 17, T. 19 N., R. 15 E., M. D. M.

Lake and its junction with Independence Creek, and is shown in fig. 12. It occupies a valley of irregular width, extending about 3 miles up from a narrow canyon through which the stream flows, and where

[1] Twelfth Ann. Rept. U. S. Geol. Survey, Pt. II.

it is proposed to construct the impounding dam. The altitude of the stream bed at this point is about 6,460 feet above sea level. The tributary drainage area, including the watershed above Webber Lake, is 33 square miles in extent, lying to the north and west of Mount Lola, the highest peak in this part of the Sierras. The major part of the area has an altitude of more than 7,000 feet. A view of the river a half mile below Webber Lake is shown in Pl. V, *B*.

The survey which was made during 1889–90 consisted of the measurement of a cross section of the canyon at the dam site, the meandering of a contour 60 feet above the base of the proposed dam, and the measurement of several cross sections of the valley below this contour. The height of the dam proposed was 60 feet, the area inclosed

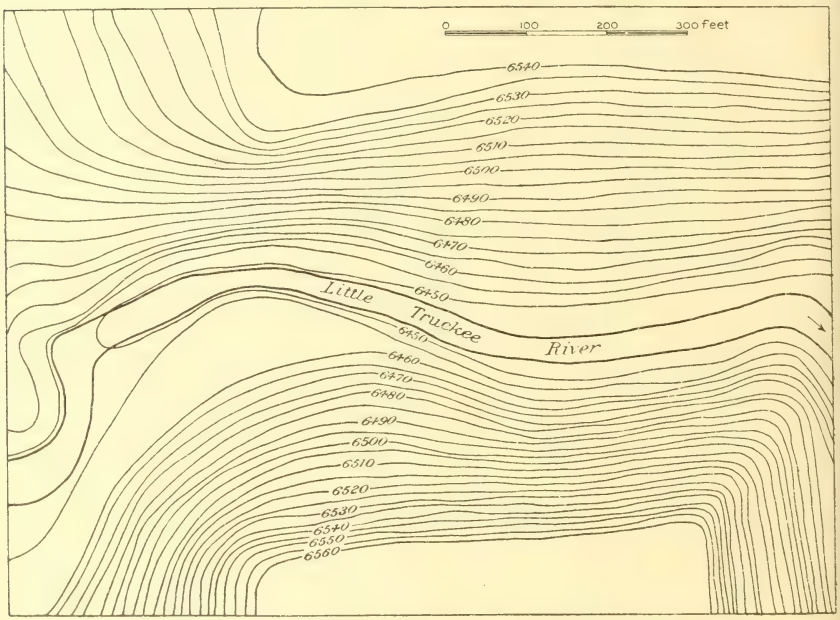


FIG. 13. Contour map of dam site of Little Truckee reservoir No. 1.

by the 60-foot contour 450 acres, and the approximate contents 10,100 acre-feet. An examination of this site made in 1900 demonstrated the feasibility and economy of raising the water 18 feet higher than was contemplated by the earlier survey, by constructing the dam a little farther down the canyon and raising it to a height of 87 feet, the crest being 7 feet above the highest flow line in the reservoir, and the base 2 feet lower than at the site previously selected. A contour map of the dam site now proposed is shown in fig. 13. A rough preliminary survey was made for the purpose of determining approximately the area and capacity of the reservoir which would be formed by the higher dam. The area was found to be about 710 acres, and the capacity about 20,540 acre-feet.

No definite data of the amount of the water supply are in existence. The precipitation is known to be greater than at Independence Lake, but no measurements of the run-off from the basin of Little Truckee River have ever been made, except at a point near its mouth, where the drainage from its entire watershed, 179 square miles in extent, is concentrated. During the year 1890 a continuous record of discharge was kept at this point from April to October, inclusive, the total run-off for the period being 338,753 acre-feet, equivalent to a depth of 35½ inches over the entire watershed. The run-off from the portion of the drainage basin above the reservoir site under consideration, where the precipitation is far greater than on the lower part, which is also less precipitous, was of course much more than the average. During the same period the discharge of Truckee River below Boca, where the Little Truckee joins the main stream, was 968,334 acre-feet, from a total drainage area of 902 square miles, or 1,071 acre-feet per square mile. The year 1890 was one of abnormally large water supply, but, no record of the discharge of Little Truckee River having been kept during drier years, it is impossible to make a direct comparison between the run-off from its watershed and that from other portions of the Truckee Basin for such years. Yet if, as seems reasonable, somewhere near the same relative proportion of the total run-off from the upper portion of the drainage basin (above Stateline Mills) is supplied by the Little Truckee during the same months of each year, it is possible to roughly approximate the total discharge of that stream during that period in 1900, and this has been done.

The run-off above Boca from April to October, inclusive, 1890, being 1,071 acre-feet per square mile, the total run-off above Stateline Mills during the same period—the area being 955 square miles and the additional drainage area being high and precipitous—would be about 1,022,800 acre-feet. Of this total Little Truckee River supplied 33⅓ per cent. During the same months of the year 1900 the total flow of the Truckee at Stateline Mills was 305,578 acre-feet. The probabilities are that even a larger proportion than in 1890 was furnished by Little Truckee River, inasmuch as during a considerable portion of the time no water was flowing from Lake Tahoe, while during 1890 the gates in the outlet to that lake were not at any time closed. However, if not more than 33⅓ per cent came from that basin, the run-off must have amounted to 100,840 acre-feet. Owing to the diminished precipitation over the drainage area, it is certain that a much greater proportion of the run-off was from the upper portion of the watershed, where the rainfall and snowfall are heaviest, than was the case in 1890. In the former years the 33 square miles of watershed above the proposed Little Truckee reservoir No. 1 probably yielded one-fourth of the total supply, while during 1900 it is likely that fully one-third, or more than 33,000 acre-feet, came from the same area, and

during the remaining five months of the year it is safe to estimate that not less than 6,000 acre-feet of water flowed past this point.

Thus if the foregoing reasoning be correct, and it is certainly within the realm of probability and is the only foundation upon which to base even an approximate estimate, it appears to be, and the writer believes it is, perfectly safe to rely on this reservoir being filled annually, even during dry years, and to count on there being, besides, a surplus of from 18,000 to 19,000 acre-feet available for storage at other points, while during years of average rainfall there will certainly be a much larger supply than that estimated.

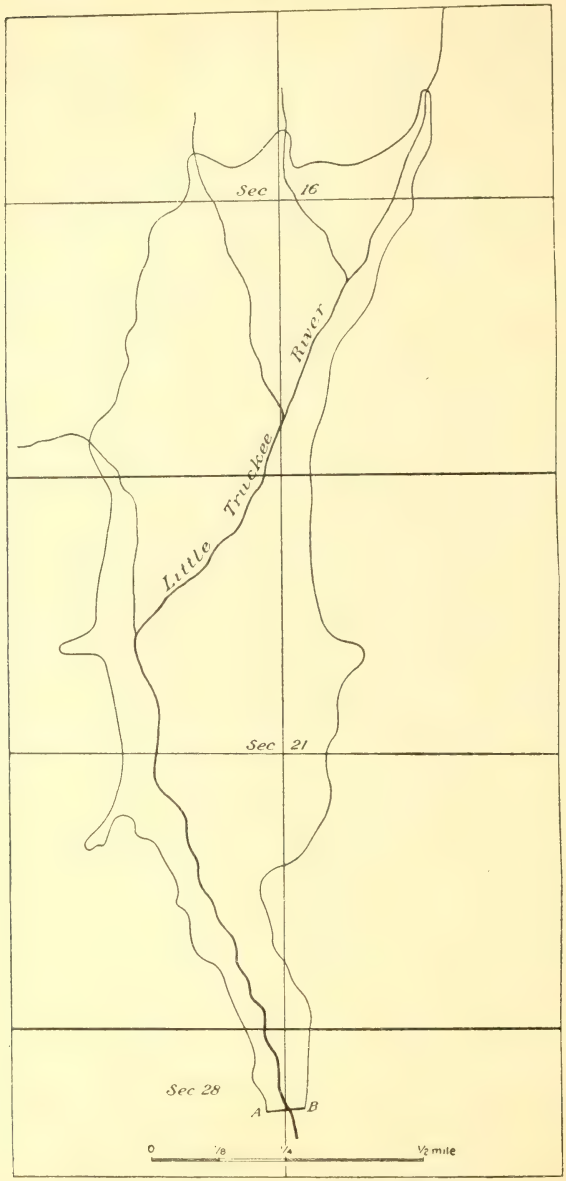


FIG. 14.—Map of Boca reservoir site, in secs. 16, 21, and 28 of T. 18 N., R. 17 E., M. D. M.

The dam estimated upon is of earth, of the hydraulic-fill type, the conditions being favorable for that method of construction. On either side of the canyon is earth of a sandy loam character, with a sufficient percentage of clayey matter to render the embankment water-tight when deposited in that manner; and the grades from the base of the mountains, a considerable distance back from the edge of the canyon, are ample for sluicing. By constructing from a creek on the south side of the valley a ditch having a length of about 2½ miles and traversing ground through

which construction would be comparatively easy, it will be possible to deliver at the dam, and at a considerable elevation above its crest, whatever volume of water may be required for handling the material. While extremely flat slopes are not essential in an earth dam constructed by this method, to be on the side of safety the slopes allowed in the structure estimated upon are 3 to 1 and 2 to 1 on the inner and outer faces, respectively. The former slope is designed to be paved with broken stone and cobbles to protect it from wave action. The crest of the dam will be 24 feet wide and 490 feet in length.

The arrangement of the outlet works, which are designed to be located 7 feet above the base of the dam, is identical with that described for the Donner Lake reservoir. The wasteway will be around the north end of the dam, discharging back into the stream several hundred feet beyond its lower toe. It is designed to have a discharging capacity of 2,500 second-feet with the water in the reservoir 2 feet below the top of the dam, its crest, arranged as a weir, being 10 feet below that of the dam.

The estimate contemplates the construction of a concrete waste weir and a wooden discharge flume. The character of the substrata at the dam site is unknown, but it is believed that the provision in the estimate for preparing foundations is sufficient to cover the cost of properly connecting the artificial fill with approximately impervious material beneath the surface of the ground.

The assumed elevation of the lowest part of the stream bed at the dam site is 6,458 feet above sea level. The outlet gates are designed to be placed at an elevation of 6,465 feet, and the ordinary high-water flow line in the reservoir will be at 6,528 feet. The 60-foot contour of the earlier survey referred to corresponds to the elevation of 6,520 feet, and the area embraced within and the capacity up to that contour are accepted at the figures given by that survey.[1] The 6,528-foot contour was plotted approximately (see fig. 12, p. 61) and the area determined by planimeter. The areas and capacities are as follows:

Area and capacity of proposed Little Truckee reservoir at different elevations.

Contour.	Area.	Capacity.	Contour.	Area.	Capacity.
Feet.	*Acres.*	*Acre-feet.*	*Feet.*	*Acres.*	*Acre-feet.*
6,465	[a]10	[b]	6,528	710	20,540
6,520	450	10,100			

[a] Estimated. [b] Level of outlet.

Nearly all of the land which would be flooded by this reservoir is in private ownership, and part of it is under fence, though it is used only for pasture during the summer. There are also upon the land a

[1] Twelfth Ann. Rept. U. S. Geol. Survey, Pt. II.

small frame house and barn. These, however, are cheap structures, and while they are within the basin and would have to be paid for with the right of way over the land, they would not very greatly increase the cost. In the following estimate the sum of $10,000 is allowed for right of way and damages to property, and this sum is deemed ample. The following is the estimate which has been prepared:

Estimate of cost of proposed Little Truckee reservoir.

Dam:		
Hydraulic filling, 150,000 cubic yards, at $0.10		$15,000
2½ miles of ditch to supply water for fill		1,500
Preparing foundation		1,000
Riprap revetment, 8,000 square yards, at $0.75		6,000
Outlet works:		
900 feet of 30-inch cast-iron pipe, at $8 laid	$7,200	
330 cubic yards of concrete incasing pipe, at $8.50	2,805	
160 cubic yards of concrete for gate tower, at $10	1,600	
Valves, gate, and hoist complete	1,250	
Cable-suspension footbridge and gatehouse	845	
		13,700
Wasteway		4,000
Damages to land and improvements		10,000
Engineering		5,000
Contingencies, 10 per cent		5,620
Total		61,820

The cost per acre-foot of storage capacity is $3.01.

A map of Boca reservoir site is shown in fig. 14 (p. 64).

HENNESS PASS VALLEY.

This reservoir site, which is shown in outline in fig. 15, occupies a small basin immediately to the north of the valley of Little Truckee River, opposite the junction of that stream and Independence Creek, from which it is separated by a narrow, rocky ridge. About 200 acres of the floor of this basin are perfectly level, somewhat marshy in character, and on the west and south are bounded by the narrow ridge mentioned, which rises from it abruptly, while to the north and east the ground rises very gradually. The elevation is about 6,367 feet above sea level. The immediate drainage area consists of 4½ square miles of undulating ridges almost bare of timber. The main water supply for the reservoir will be drawn from Little Truckee River, by means of a canal about 4 miles in length, having a capacity of 100 cubic feet per second, heading a short distance below the dam for Little Truckee reservoir, last described. The total drainage area, including that of the reservoir mentioned and the territory whose drainage would be intercepted by the supply canal, is 41 square miles. The discussion of the water supply for the Little Truckee reservoir, showing, so far as is practicable in the absence of complete data, the volume available at that point, indicates a surplus sufficient to fill the reservoir contemplated, even in dry seasons, so that there can be no question about its sufficiency in years of normal precipitation, while the run-off from 8 square miles of additional catchment area

will still further tend to insure this, though the precipitation on the latter area is lighter.

The dam site, shown in fig. 16, is in the canyon leading out of the valley to Little Truckee River. The maximum height of the dam will be 56 feet, its length on top 720 feet, and its top width 24 feet. It will be of earth, of the hydraulic-fill type, with the same section as the dam last described. The water for making this fill will be furnished by the reservoir-supply canal from the Little Truckee, which can be brought in about 25 or 30 feet higher than the proposed crest of the dam. The material for the structure is a clayey earth containing some gravel, cobbles, and bowlders. The outlet works estimated upon are of the same type as those described for the Donner Lake and the Twin Valley reservoirs, and will be located 5 feet above the base of the dam. A very small wasteway, located at a depression in the rocky ridge at the south side of the reservoir, will

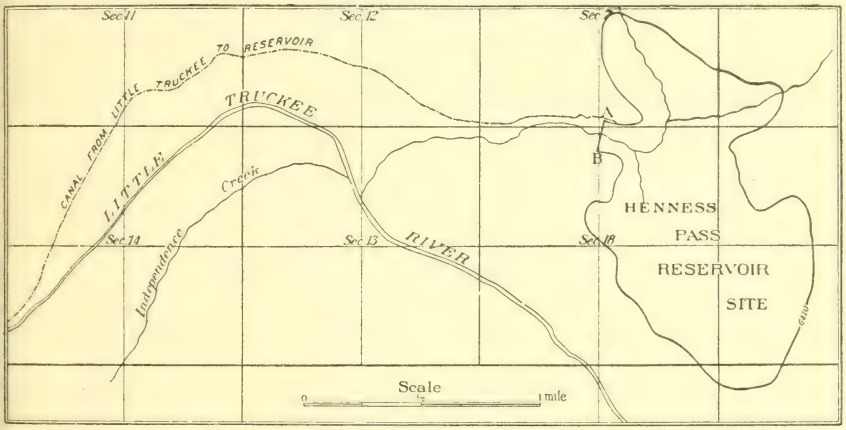


FIG. 15.—Map of Henness Pass Valley reservoir site and supply canal. The site occupies portions of secs. 7, 8, 18, and 19 in T. 19 N., R. 16 E., M. D. M.

be required, as almost the entire water supply comes from Little Truckee River and can be shut off at will.

This reservoir site was surveyed by Mr. T. K. Stewart, for Hon. Francis G. Newlands, in 1890, a contour 50 feet above the floor being meandered and a few cross sections of the basin measured, from which data the area and capacity were computed. The former was given as 590 acres, which is accepted as correct for the purpose of this report; but the latter, as demonstrated by measurements made in October, 1900, was overestimated. The later survey, while furnishing sufficient information to determine the approximate capacity of the reservoir up to the 50-foot contour mentioned, was not close enough to permit accurate plotting of contours intermediate between that and the base of the dam. The elevation of the floor of the canyon at the dam site is taken at 6,360 feet above sea level. The outlet works are planned to be at 6,365 feet and the highest flow line in the reservoir at 6,410 feet. The estimated capacity is 17,000 acre-feet. The lands

which would be flooded by this reservoir are all in private ownership, but are entirely unimproved. They furnish some grazing in the summer, but are valuable for no other purpose. In the following estimate the sum of $3,000, or a little more than $5 an acre, is allowed

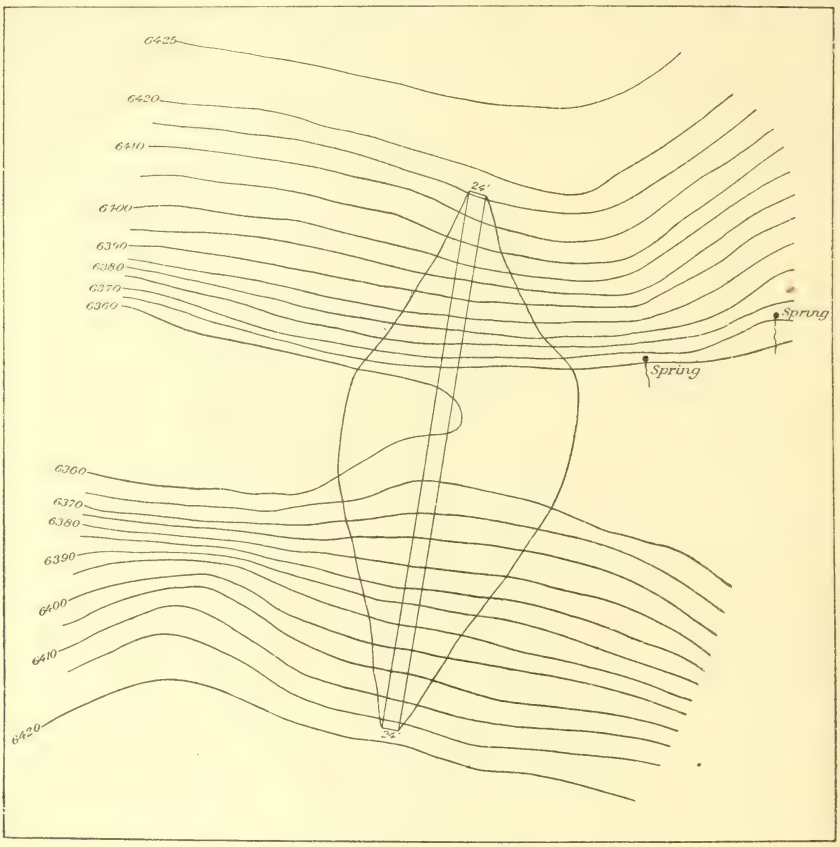


FIG. 16.—Contour map of Henness Pass Valley dam site.

for the cost of right of way over them, and this amount is considered liberal. The following is the estimate which has been prepared:

Estimate of cost of proposed Henness Pass Valley reservoir.

Dam:		
Hydraulic filling, 108,800 cubic yards, at $0.10		$10,880
Preparing foundation		1,000
Riprap revetment, 8,400 square yards, at $0.50		4,200
Supply canal, complete, 4 miles, at $3,000		12,000
Outlet works:		
620 feet 30-inch cast-iron pipe laid, at $8	$4,960	
260 cubic yards concrete, encasing pipe, at $8.50	2,210	
Gates and hoist, complete	1,000	
		8,170
Right of way, complete		3,000
Engineering		4,000
Contingencies, 10 per cent		4,325
Total		47,575

The cost per acre-foot of storage capacity is $2.80.

DOG VALLEY.

This reservoir site, shown in fig. 17, occupies a small valley situated between outlying spurs of the Sierra Nevada just west of the boundary line between California and Nevada, and about 4 miles northwest of the town of Verdi, Nev. The elevation is about 5,700 feet above sea level. The catchment basin comprises 16 square miles, ranging in altitude from that of the reservoir to 8,500 feet, most of which is covered with pine and fir timber, and is quite precipitous. This site

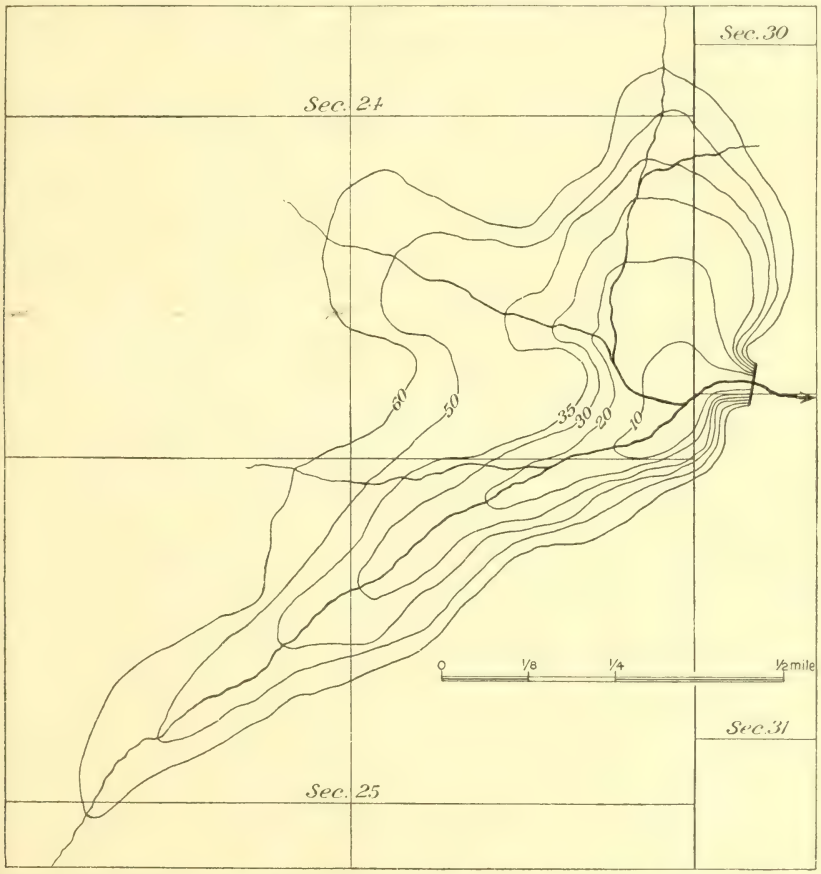


FIG. 17.—Contour map of Dog Valley reservoir site, in secs. 24 and 25 of T. 20 N., R. 17 E., and secs. 30 and 31 of T. 20 N., R. 18 E., M. D. M.

was surveyed by the writer in 1895, the topography of the lower portion of the valley being taken by means of transit and stadia, and the contours plotted as shown in fig. 17. A cross section of the outlet canyon immediately below the valley, at what appeared to be the most favorable site for a dam was also measured (see fig. 18), and it was found that by the construction of a dam to a maximum height of 65 feet with a top length of 235 feet, a reservoir having a surface area of 274 acres and a capacity of approximately 5,785 acre-feet would be created. No exact data of the water supply for this reservoir have

been collected, only three measurements of the discharge of Dog Valley Creek, the outlet of the basin, having been made. The first of these was on May 22, 1889,[1] at the point where the creek joins Truckee River, opposite the town of Verdi, when the discharge was 7 cubic feet per second. The last two were on July 26 and September 10, 1900, when 0.40 and 0.80 second-foot, respectively, were found a short distance above where the earlier measurements were made. The discharge at the reservoir site, except at flood stage, is always greater than at the points described, which are about 3 miles below. A considerable loss occurs by absorption in the bed of the canyon, which is filled with gravel and bowlders to an unknown depth, and there are no affluent streams to compensate for this loss. The measurements were all made after the flood season had passed, the snow falling on this watershed melting much earlier than on other parts of the Upper Truckee Basin. Usually the greatest run-off from the Dog Valley drainage area occurs during the latter part of March and through the month of April.

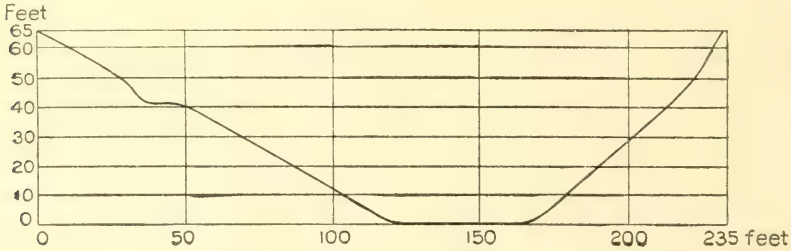


FIG. 18.—Profile of Dog Valley dam site.

In the absence of definite data on which to base an estimate of the water supply available for storage in the proposed Dog Valley reservoir, a rough approximation can be reached by computing the precipitation which should occur at this altitude, from the table of "Increase in precipitation with each 100-foot rise in elevation, with Wadsworth, Nev., as a base," page 15, and the probable run-off from a watershed composed almost entirely of precipitous mountains. The mean precipitation at an elevation of 5,700 feet, the altitude of the lowest point in the basin, which is taken in order to be on the side of conservatism, would be 25.25 inches, and the run-off, computed from the Newell curve, a trifle more than 11 inches, or a total of 9,420 acre-feet from the 16 square miles of drainage area, which is more than 60 per cent greater than the reservoir capacity. Therefore, the writer, who has been acquainted with the Dog Valley Basin for the last ten years and has observed the creek quite frequently during that period, believes that the water supply will be ample even in dry seasons—and it certainly will be ample during seasons of normal rainfall—to fill the proposed reservoir, and that the flow of the creek at the lowest stage in the summer will nearly offset the loss from evaporation, which at this point will be greater than from the reservoirs previously described.

[1] Eleventh Ann. Rept. U. S. Geol. Survey, Part II.

To form this reservoir, as already stated, will require a dam having a maximum height of 65 feet and a top length of 235 feet. It should be of the rock-fill type, with an earthen face on the upstream side. The slope of the rock fill on the lower side will be 1½ horizontal to 1 vertical, and on the line of contact with the earth it will be vertical. The earth will be obtained from the bed of the reservoir and be placed with scrapers. It will have a slope of 2½ to 1 on the upper face, which will be pitched with stone to protect it from wave action. The top width of the dam will be 10 feet. The outlet will be by means of a cast-iron pipe embedded in concrete in a tunnel run through the bed rock in the projecting abutment. The assumed elevation of the stream bed at the dam site is 5,700 feet above sea level. The outlet works will be at 5,710 feet elevation, the highest flow line in the reservoir at 5,760 feet, and the crest of the dam at 5,765 feet. The wasteway will be arranged as a weir discharging over a porphyry ledge at the south end of the dam, the crest of which will be 5 feet below the crest of the dam.

The reservoir contours were plotted to scale, as shown in fig. 17, and the areas inclosed were determined by planimeter. The areas and capacities thus determined are as follows:

Area and capacity of Dog Valley reservoir site at different elevations.

Contour.	Area.	Capacity.	Contour.	Area.	Capacity.
Feet.	*Acres.*	*Acre-feet.*	*Feet.*	*Acres.*	*Acre-feet.*
5,700	(*a*)	0	5,735	110	1,240
5,710	*b* 10	0	5,750	188	3,475
5,720	36	230	5,760	274	5,785
5,730	74	780			

a Base of dam. *b* Level of outlet gates.

The land which would be flooded by the construction of this dam is all in private ownership and most of it under fence, but it is used only for pasturage. In 1895 $1,800 was the price placed upon it, and as its value has not been enhanced since that time this sum has been included in the estimate to provide for its purchase for reservoir purposes. The following is the estimate of cost:

Estimate of cost of Dog Valley reservoir.

Dam:		
Rock filling, 13,380 cubic yards, at $0.75		$10,035
Earth embankment, 25,500 cubic yards, at $0.25		6,375
Riprap revetment, 2,800 square yards, at $0.50		1,400
Preparing foundation		500
Outlet works:		
300-foot tunnel, 3½ by 5 feet, at $6	$1,800	
300 feet of 24-inch cast-iron pipe, at $5	1,500	
110 cubic yards of concrete incasing pipe, etc., at $10	1,100	
Gates and hoist, complete	500	
		4,900
Wasteway, complete		1,250
Rights of way		1,860
Engineering		3,000
Contingencies, 10 per cent		2,926
Total		32,186

The cost per acre-foot of storage capacity is $5.564.

PRESENT USES OF WATER AND EXISTING WATER RIGHTS.

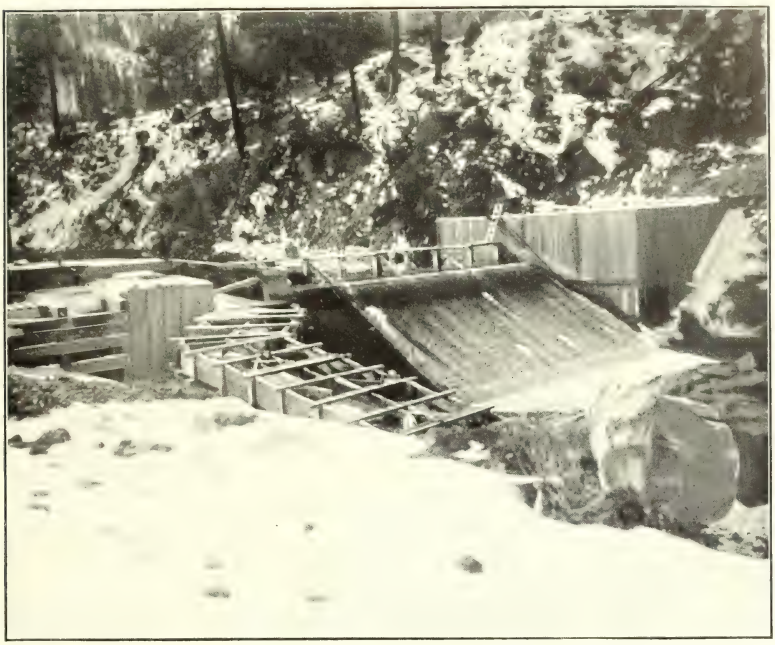
In the foregoing pages an effort has been made to show the extent of the water supply of the Truckee Basin and the means by which it can be conserved to the best advantage. Before proceeding to the consideration of the possibilities of and the means for its use for irrigation and other purposes, it is necessary to inquire into the existing rights to the waters of the stream which have become vested and can not be disturbed.

POWER.

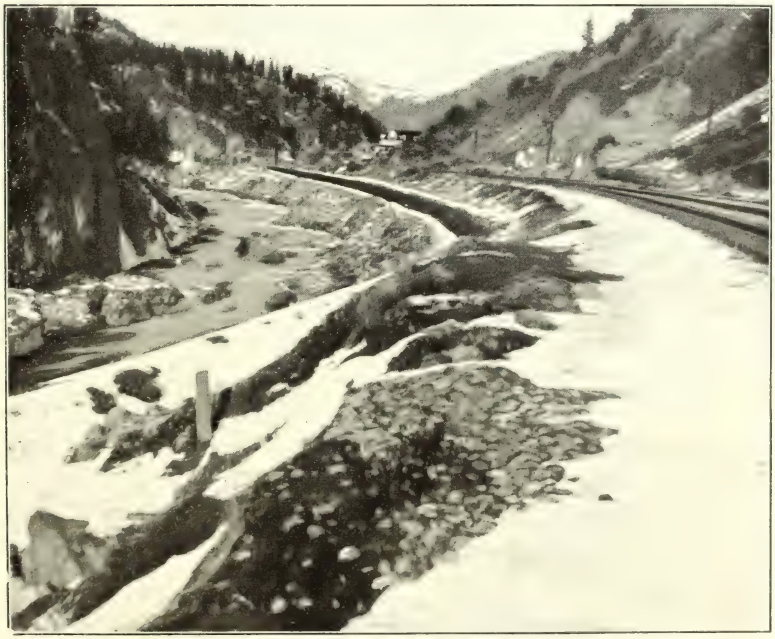
At the present time the waters of Truckee River are employed by eight companies, at as many localities on the stream, for the generation of power, as follows: Truckee Lumber Company, at Truckee, Cal.; Floriston Pulp and Paper Company, at Floriston, Cal.; Truckee River General Electric Company, at Mystic, Cal.; Verdi Mill Company, at Verdi, Nev.; Reno Electric Light and Power Company, a short distance above Reno, Nev.; Riverside Flour Mill Company, at Reno, Nev.; Reno Reduction Works, a short distance below Reno, Nev.; and Wadsworth Light and Power Company, at Wadsworth, Nev.

At Truckee the Truckee Lumber Company operates a sawmill and a door, sash, and box factory. To supply power for these the water is diverted directly from the main river a short distance below the mouth of Donner Creek by means of a timber dam and a short canal. The sawmill is run by a turbine working under an effective head of 21 feet, and requires about 160 second-feet of water to generate the 300 horsepower necessary to run it to its full capacity. The factory is located below the sawmill, is operated by a turbine working under a head of 26 feet, and requires about 110 second-feet of water, which is taken from the sawmill tailrace to run it to its full capacity. It is operated the year round, but the mill is always closed down from December 1 to about May 1.

The Floriston Pulp and Paper Company, the next user of water for power purposes below Truckee, is engaged in the manufacture of paper from wood pulp. For the operation of the plant the water is diverted from the river by means of a timber dam (see Pl. VI, *A*) and is conveyed to the mill through a wooden stave pipe 9 feet in internal diameter and 2,000 feet long (see Pl. VI, *B*). Six turbines, varying in capacity from 100 to 1,000 horsepower and aggregating 2,700 horsepower, are employed to run the machinery, the water being delivered to each wheel under a head of 51 feet. It is estimated by the owners of this plant that 1,500 horsepower is required to run it to its full capacity, to generate which about 320 cubic feet per second of water is needed. The flow of the river during the fall and winter, however, is frequently less than that amount, and as a consequence the company is now preparing to install steam power for supplemental use.



A. DAM OF FLORISTON PULP AND PAPER COMPANY IN TRUCKEE RIVER.



B. TRUCKEE RIVER CANYON, LOOKING DOWNSTREAM FROM FLORISTON PULP AND PAPER COMPANY'S DAM.

Less than 2 miles below Floriston is the power plant of the Truckee River General Electric Company, which is engaged in the development of power for transmission, electrically, to Virginia, Nev., for use in mining operations. (See Pls. VII and VIII.) The water employed for this purpose is taken from the river immediately below the Floriston paper mills, and is conveyed by means of a wooden flume (Pl. VII) 8,500 feet in length to the power house, where it is delivered to the wheels under a head of 85.6 feet. The inside dimensions of the flume are, width 10 feet and depth 7 feet. Its carrying capacity when filled to a depth of 6 feet is estimated at 300 second-feet.

Several years ago water from Truckee River was employed at Marmol, about 3 miles above the town of Verdi, to supply power for cutting and dressing marble, but this plant has not been in operation for more than three years past, and it was not possible to ascertain either the amount of water claimed or the power required for its operation.

The Verdi Mill Company requires and uses a short distance above the town of Verdi about 90 second-feet of the river water, under a head of 24 feet, to supply power for its door, sash, and box factory.

About 1½ miles above Reno the Reno Electric Light and Power Company diverts water from the river to supply power for lighting the town. For this purpose it is estimated by the electrician in charge that 200 horsepower is now employed, and as the net head on the water wheel is about 38 feet, approximately 60 cubic feet per second are necessary. The capacity of the canal and flume from the river is probably double this, however.

In the town of Reno is the Riverside flour mill, requiring 56 horsepower to run to its full capacity, to supply which about 40 second-feet of water are diverted from the river and delivered to the wheel under a head of 16 feet.

A short distance below the Riverside flour mill the Reno reduction works diverts water for the development of power to operate the ore-crushing machinery in the plant, to run which requires about 75 horsepower. The turbine for developing this power is run under a net head of about 13 feet, and approximately 56 cubic feet of water per second are required.

The last power plant on Truckee River, that of the Wadsworth Light and Power Company, is operated to light the town of Wadsworth with electricity. For this purpose about 17 second-feet of water are diverted from the river above the town and led, by a canal 6 miles in length, to the power station, where it is delivered to the wheels under a working head of 44 feet.

From the foregoing it will be seen that the existing rights to the waters of Truckee River for power purposes amount to 160 cubic feet per second during part of the year, and to 110 cubic feet per second during the remainder of the year, which comprises the most of the period of low water at Truckee, and a maximum of 320 second-feet at Floriston, which is more than sufficient to supply all of the requirements of

existing power plants below that point. It would therefore appear that if 160 and 320 second-feet of water be supplied at Truckee and Floriston, respectively, from May 1 to December 1, and the minimum discharge from December 1 to May 1 be maintained at 110 and 300 second-feet, not only will the existing rights be supplied but the companies owning them will be greatly benefited.

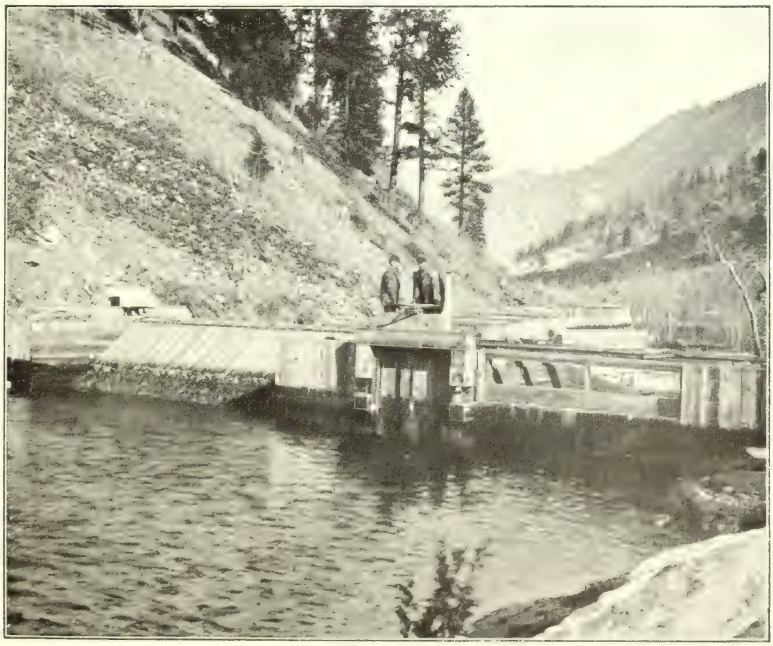
IRRIGATION.

Within the basin of Truckee River there are under irrigation at the present time about 42,384 acres of land, of which 28,288 acres are supplied with water diverted directly from the main river by means of canals; 2,130 acres are supplied from seepage water collected, by

FIG. 19.—Map showing location of irrigation canals in western portion of the Truckee Basin.

1. Steamboat canal.
2. Mayberry ditch.
3. Truckee Meadows ditch.
4. South Side irrigating canal.
5. Indian Flat ditch.
6. Cochran ditch.
7. Scott's ranch ditch.
8. Abbey ditch.
9. Wilson ditch.
10. Pioneer ditch.
11. Merrill ditch.
12. Highland ditch.
13. Hogan ditch.
14. Mayberry & Carr ditch.
15. Mayberry Northside ditch.
16. Orr ditch.
17. Countryman ditch.
18. Chisholm ditch.
19. Sullivan ditch.
20. Auburn ditch.
21. (?)
22. North Truckee irrigating ditch.
23. Sessions ditch.
24. Mitchell & Carmac ditch.
25. Glendale ditch.
26. Crane & Bullock ditch.
27. Alexander ditch.

A. FLUME OF TRUCKEE RIVER GENERAL ELECTRIC COMPANY ON SIDE HILL ABOVE MYSTIC, CAL.



B. HEADWORKS OF FLUME OF TRUCKEE RIVER GENERAL ELECTRIC COMPANY AT FLORISTON, CAL.

means of drain ditches, before it reenters the river, and 11,966 acres are supplied from various tributary streams. (See figs. 19 and 20.) Of the latter area, 10,621 acres are irrigated from Steamboat Creek and its tributaries, though the supply is sometimes short. All of these lands are in the State of Nevada, about 959 acres being

FIG. 20.—Map showing location of irrigation canals in eastern portion of the Truckee Basin.

1. (?)
2. (?)
3. (?)
4. (?)
5. Herman ditch.
6. Fellnagle ditch.
7. O'Brien ditch.
8. Wadsworth irrigating ditch.
9. Olinghouse ditch.
10. Proctor ditch.
11. Hill ditch.
12. (?)
13. (?)

between the California-Nevada boundary line and the junction of Hunter Creek with Truckee River; 30,000 acres are in the Reno Valley; 8,500 acres are in the Washoe, Pleasant, and Steamboat valleys, to the south of the Reno Valley, and 2,925 acres are along the river below Vista, 500 acres of which are on the Pyramid Lake Indian Reservation and are cultivated by the Piute Indians.

A number of discharge measurements were made of the principal canals diverting water from Truckee River for the irrigation of these lands, but no attempt was made to ascertain the amount of water taken from the river by the numerous small ditches, nor were any of

the ditches below the Reno Valley measured. During the time that the measurements were being made and for some time afterwards the entire flow of the river was diverted. The following are the results of the measurements:

Measurements of flow of irrigating ditches taking water from Truckee River in Nevada.

SOUTH SIDE.

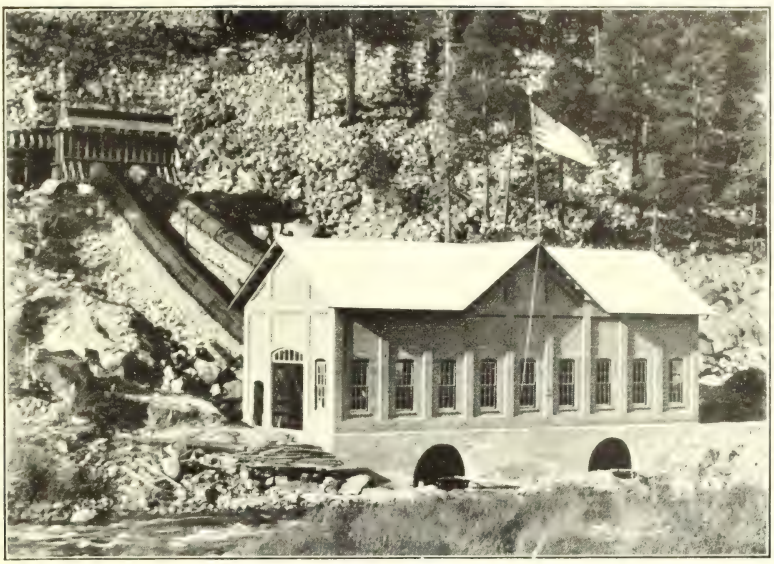
Date.	Name of ditch.	Length.	Discharge.
1900.		*Miles.*	*Sec-ft.*
July 3	Steamboat	31	51.2
July 30	do		8.4
1899.			
September 4	Mayberry		46.9
1900.			
July 3	Mayberry		41.7
July 30	do		39.7
July 10	Lake or Truckee Meadows	14	58.4
July 30	do		36.4
July 7	Cochran	8	14.5
July 31	do		26.7
July 7	Scott's ranch	2	29.6
July 31	do		13.5
July 8	Abbey	3	3.6
July 31	do		4.4
July 8	Wilson	1	4.2
August 1	do		3.7
July 8	Pioneer	3¾	12.7
August 1	do		21.1

NORTH SIDE.

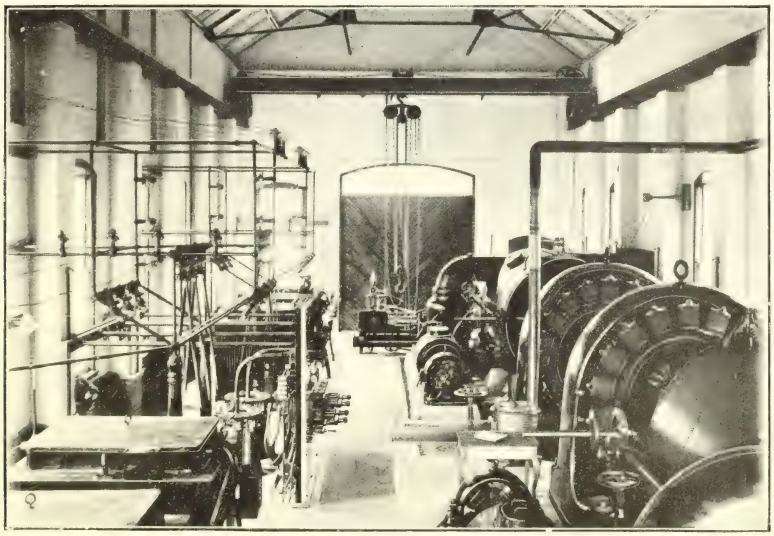
Date.	Name of ditch.	Length.	Discharge.
1900.			
September 4	Highland	14¼	16.7
July 9	do		11.8
July 30	do		17.5
1889.			
September 4	Orr		42.0
1900.			
July 6	Orr		83.8
July 30	do		60.6
July 9	Auburn		15.8
July 7	Sullivan	3½	24.7
July 31	do		25.0
July 10	North Truckee	7	31.4
August 1	do		18.8
July 8	Sessions	1	5.4
August 1	do		8.0
July 8	Mitchell & Carmac	¾	14.0
August 1	do		6.8
Do	Glendale	3¼	2.7

At the time of making the foregoing measurements an attempt was made to segregate the lands supplied from each ditch, with a view to approximating the duty of water under each, but owing to the fact that many of the farms were supplied from more than one ditch this was found to be impossible.

In the lower part of the Reno Valley, called the Truckee Meadows, several drain ditches have been constructed to carry off the seepage from the higher irrigation. These discharge into Truckee River a short distance above the United States Geological Survey gaging



A. POWER HOUSE OF TRUCKEE RIVER GENERAL ELECTRIC COMPANY AT MYSTIC, CAL.



B. INTERIOR OF POWER HOUSE OF TRUCKEE RIVER GENERAL ELECTRIC COMPANY.

station at Vista, but a portion of the water collected by them is employed for irrigation, which explains the fluctuations in the discharge of the stream at that station during July and August, the entire flow during the greater part of those months coming from that source.

No attempt was made to ascertain the amount of water employed for irrigation on the lands along Steamboat Creek and in the Washoe Valley, but it is certain that the average quantity per acre is materially less than in other parts of the Truckee Basin.

SUMMARY.

From the foregoing it will be seen that the vested rights to the waters of Truckee River are as follows: For power purposes, 300 cubic feet per second at Floriston and Mystic during the period when the river, unaided by storage, discharges that volume; and for irrigation purposes below those points sufficient water to irrigate 27,493 acres of land in the Reno Valley. With reasonable care and economy in its use the latter quantity should not exceed 275 second-feet, or 1 second-foot for each 100 acres. Thus the water employed for generating power at Floriston and Mystic, which can be applied to the lands below, is more than ample to supply existing water rights for irrigation. This volume, with the surplus from the power plants mentioned, will supply the requirements of the power plants at Verdi and Reno, as many of the irrigating canals are taken out below them, and the water which will necessarily return to the river from seepage is ample for the irrigation of the lands below Vista and for the purpose of the Wadsworth Light and Power Company. Thus it appears that the waters of Truckee River in excess of 300 cubic feet per second are available for use in the extension of the irrigated area or for other purposes. But since that volume of water (300 cubic feet per second) is at all times required for power purposes, the river should never be permitted to fall below that stage.

IRRIGABLE LANDS.

While almost the entire water supply of Truckee River comes from the upper portion of the basin, where all of the projected storage reservoirs would be located, it is in the lower part of the basin that the best agricultural lands are found, and where practically all of the water will be used in irrigation. There is a considerable area in Martis Valley and along Prosser Creek, also along Little Truckee River in California, which is favorably situated for irrigation, but the climate is not adapted to any but the lowest class of farm products, hence it is not deemed advisable to devote to their irrigation water which is needed and can be so much more profitably employed in the valleys farther east and at lower altitudes.

Within the Reno Valley and to the east of the Nevada-California boundary line, including the areas already under cultivation, are 42,000 acres of land suitable for farming purposes, which are already commanded by canals from Truckee River. Lying along the foothills to the north and northeast of the town of Reno, and in the Lemmons, Prosser, Spanish Springs, and Warm Springs valleys, are fine tracts of sagebrush land, aggregating about 75,000 acres, which are within reach of the Truckee's waters. On the lower stretches of the river, in the canyon below the Reno Valley and in the vicinity of Wadsworth and Pyramid lakes, are, approximately, 30,000 acres of good land, about 20,000 acres of which are embraced in the Pyramid Lake Indian Reservation, while to the east and southeast of Wadsworth, but over a low, flat divide from which the drainage is toward Carson River, and including a part of the Lower Carson or Carson Sink Valley, are more than 100,000 acres which can be reached by canals from Truckee River.

Besides these there are not less than 3,000 acres of land along the foothills bordering the Reno Valley, to the south of the river, 1,345 acres of which are already irrigated, which can be supplied with water from the numerous small streams which flow down from the northern part of the Tahoe Range; while still farther south, in the Steamboat, Pleasant, and Washoe valleys, are more than 12,000 acres of good land which could be reached by ditches from Steamboat Creek and the streams flowing into the Washoe Valley from the west. The latter, however, being beyond the reach of the stored water under consideration, and no study of the supply for their irrigation having been made, are left out of the estimates of irrigation possibilities. It is believed that, reenforced and regulated by storage reservoirs, the water supply will be sufficient, not only to maintain the flow of Truckee River at a minimum of 300 second-feet, but with economical methods of distribution and application, to properly irrigate 219,000 acres of the foregoing lands, as follows:

	Acres.
From small tributaries south of river	3,000
In the Reno Valley, from Truckee River	42,000
On foothills north of Truckee River, and in the Lemmons, Prosser, Warm Springs, and Spanish Springs valleys	75,000
Below the Reno Valley and north of Wadsworth	24,000
East and southeast of Wadsworth	75,000
Total	219,000

OWNERSHIP OF LANDS.

No attempt was made to ascertain in detail the ownership of all of the lands included in the foregoing table, but from the maps in the United States land office and in the offices of the assessors of Washoe,

Lyon, Churchill, and Storey counties, in Nevada, in which the lands are situated, the following general information was obtained:

All of the lands, except about 9,000 acres in the northern end of the Warm Springs Valley and perhaps a part of those in the Carson Sink Valley, are within the limits of the grant to the Central Pacific Railroad Company, and consequently half of them—the odd-numbered sections—are, or originally were, the property of that company. The 42,000 acres in the Reno Valley are all in private ownership, as are also the 3,000 acres of foothill lands south of Truckee River. Of the 75,000 acres of irrigable lands north of Truckee River, not more than 20,000 acres still remain the property of the Government, the rest being in private ownership or the property of the railroad company. The title to the land in the vicinity of Wadsworth is approximately as follows:

	Acres.
Public domain	37,000
Pyramid Lake Indian Reservation	20,000
Central Pacific Railroad grant	37,000
Private individuals	5,000
Total	99,000

Thus it appears that, of the total area which it is estimated can be irrigated, about 25 per cent, or less than 60,000 acres, still belongs to the public domain.

DUTY OF WATER.

Under present methods of irrigation in the basin of the Truckee, especially in the Reno Valley, where a large portion of the lower lands have been converted into marshes, the duty of water is extremely low, averaging, probably, not more than 50 acres to the cubic foot per second. It is certain, however, that this can at least be doubled, so in making an estimate of irrigation possibilities with the available water supply, 1 second-foot of water measured in the river is allowed for each 100 acres in the Reno Valley, or 420 cubic feet per second for 42,000 acres. These lands in the main comprise soils of a clayey and loamy nature, varying in depth from a little more than a foot to 4 or 5 feet, underlain by gravel and bowlders; and as the grades are generally heavy the water sinking through the surface stratum drains off very rapidly.

In the valleys to the north of Truckee River and in the neighborhood of Wadsworth the soils are of a different character, and the duty of water will be higher. For the Lemmons, Warm Springs, Spanish Springs, and Prosser valleys an average duty of 150 acres to the second-foot is estimated, after making allowance for losses in transit through the main canals. On the mesa north of Wadsworth, which is partially drained by deep ravines and borders Truckee River, whose

channel is from 50 to 200 feet below the irrigable lands, the duty is estimated at 120 acres to the second-foot. To the east of Wadsworth and in the Carson Sink Valley an average of 150 acres to the second-foot is believed to be a fair duty, assuming reasonable economy in the application of the water. In each of the last two cases it is assumed that the water will be measured where taken out from the main canals.

QUANTITY OF WATER REQUIRED AND AVAILABLE.

To supply 75,000 acres of land to the north of Truckee River it will be necessary to construct a canal of sufficient capacity to divert 550 cubic feet per second, it being assumed that 50 second-feet will be lost in transit.

The main canal to supply 99,000 acres in the vicinity of Wadsworth must have a capacity of 750 cubic feet per second, or 50 second-feet in excess of the requirements of the land to be served, in order to provide for losses in the main canals. It must not be understood that the 50 second-feet allowed in each case will represent the entire loss from the main canals referred to, but when it is remembered that probably not more than 70 or 80 per cent of the total area assumed to be supplied with water will be actually under irrigation during any season, this allowance in fixing the canal capacities appears to be sufficient.

For the supply of 42,000 acres of land in the Reno Valley, with the duty assumed, 420 cubic feet per second will be diverted from the river.

The water supply of these lands will be derived from the main Truckee River, supplemented by that which will be stored in the seven reservoirs situated above the town of Verdi, in the State of California, which will discharge directly into it. The irrigation season in this region is generally considered to begin about April 1 and to end about September 1, but in the lower portion of the basin some water can be used with profit during the month of March and some will be required for garden irrigation later than September 1.

From the foregoing, from a study of the records of stream discharge given on previous pages of this report, and from the storage possibilities, the following table, showing, by months, the probable mean available flow of Truckee River at Floriston during the driest year (after deducting the proportion which will be held back by reservoirs), the total mean quantity which will be required for irrigation and for power purposes, the mean quantity expected to return to the river by seepage above Vista, the mean flow required at Floriston, which, added to the seepage water during the irrigating season, will supply all requirements, and the volume which must be drawn from the reservoirs to maintain the required flow at Floriston, has been compiled.

Table showing quantity of water required and available.

Month.	Mean available discharge of Truckee River at Floriston (dry years).	Total mean quantity of water required for irrigation and power	Mean volume of seepage or return water at Vista.	Mean flow required at Floriston.	Amount necessary to draw from reservoirs.	
	Sec.-ft.	*Sec.-ft.*	*Sec.-ft.*	*Sec.-ft.*	*Sec.-ft.*	*Acre-ft.*
January	225	300	50	300	75	4,612
February	200	300	50	300	100	5,554
March	450	400	75	400	00	000
April	700	1,100	100	1,000	300	17,851
May	1,200	1,720	120	1,600	400	24,595
June	600	1,750	150	1,600	1,000	59,595
July	200	1,400	200	1,200	1,000	61,489
August	150	1,100	200	900	750	46,117
September	150	500	150	400	250	14,876
October	300	300	100	300	00	000
November	280	300	60	300	20	1,190
December	225	300	50	300	75	4,612
Total necessary to draw from reservoirs						240,401
Total net capacity of reservoirs						288,767
Reserve capacity of reservoirs providing a margin of safety						48,366

PROPOSED DISTRIBUTION CANALS.

During the year 1889–90 a line was run from Truckee River,[1] beginning near Clarks station, on the Central Pacific Railroad, which demonstrates the feasibility and furnishes the basis for approximate estimates of cost of delivering water to the lands in the vicinity of Wadsworth. This survey, with later ones made by Mr. T. K. Stewart, C. E., supply the data for the estimates herein contained. In 1892 the author and Mr. Morris Hacker, C. E., now of Chevy Chase, Md., made surveys for and estimates of cost of a canal from a point in Truckee River, where the Floriston Pulp and Paper Company now diverts the water for the operation of its mills, to the divide between the Reno and the Lemmons valleys, with branches thence to distribute water to the other valleys lying to the north of the river. This was then known as, and will here be designated, the Truckee River Highline canal. To supply water to the lands in the Reno Valley and the Truckee Meadows several of the existing canals can be employed, notably the Highland canal on the north and the Steamboat canal on the south side of the river.

No data are at hand concerning canals or ditches required for the delivery of water from the small creeks to the foothill lands south of Truckee River, nor for distributing purposes in the Washoe Valley and on Steamboat Creek. In neither case, however, will these be of great magnitude, nor will their construction be expensive.

TRUCKEE RIVER HIGHLINE CANAL.

As previously stated, the survey of this canal line was made in 1892. It was designed to head in the left bank of Truckee River at the

[1] Thirteenth Ann. Rept. U. S. Geol. Survey, Pt. III, pp. 393–394.

place where the diversion dam of the Floriston Pulp and Paper Company has since been constructed. From that point the line as surveyed runs in a general northerly direction—nearly all the way along precipitous and rocky mountain sides—for a distance of about 12 miles, to a point west of the town of Verdi, where it turns, crosses Dog Valley Creek, and runs in a general direction a little north of east, over less precipitous and rocky ground, to the divide between the Reno and the Lemmons valleys, a total distance of 163,950 feet, or a little more than 31 miles. In its course the line traverses a great deal of ground—about 10 miles in the aggregate, more than 8 miles of which are above Dog Valley Creek—through which the construction of a water-tight canal would be so expensive that it was decided to use lumber flumes, to be built on benches cut in the mountain side, it being estimated that the interest on the additional cost of a canal through this ground would at least maintain the flumes. Besides this, the line traversing the mountain sides crosses numerous lateral drainage lines which would be passed by means of flumes supported on timber trestles. Dog Valley Creek, a little more than 14 miles from the head of the canal, flows in a deep canyon, which it is proposed to cross by means of a double line of pressure pipes 66 inches in diameter and about 1,700 feet in length. There are nine tunnels on the line, varying in length from 150 to 2,200 feet and aggregating 8,312 feet. The grades on which the canal is designed to be constructed, also its dimensions, vary with the character of the ground, as follows: Canal in earth on comparatively flat slopes, grade 0.4 in 1,000, bed width 16 feet, top width 30 feet, depth of water 7 feet; canal in rocky or clayey soil, generally on steeper hillsides, grade 0.6 in 1,000, bed width 16 feet, top width 23 feet, depth of water 7 feet; tunnels, grade 1.25 in 1,000, width 15 feet to a height of 7 feet, with arched roof, crown of arch 10 feet high; flumes, grade 0.6 in 1,000, inside dimensions 12 feet wide by 7.5 feet deep, depth of water 7 feet. The estimated capacity is 550 cubic feet per second.

BRANCH CANALS.

From the lower terminus of the main canal just described surveys were made of two main branch lines, one to the west, known as Branch canal No. 1, around the south and west sides of the Lemmons Valley, to supply about 17,000 acres of land in that valley, having a total length of 24 miles and a capacity at its head of 130 second-feet; the other, Branch canal No. 2, designed to supply about 53,000 acres in the Lemmons, Prosser, Spanish Springs, and Warm Springs valleys, was located around the east side, a distance of 21 miles, to the head of a canyon leading to the valley last mentioned, its capacity, where it leaves the main canal to be 400 cubic feet per second. Both of these lines were run on a grade of 0.6 in 1,000.

The foothill lands between the Nevada-California boundary and the terminus of the main line, comprising about 5,000 acres, can be sup-

plied directly from the main canal. No attempt was made to locate the minor ditches for the distribution of water from the main canals, but with a few exceptions these would be entirely in earth and quite easy and cheap of construction.

The surveys of this canal system, especially of the main diversion line from Truckee River to the divide north of the Reno Valley, were made with all the care and attention to details deemed requisite for the final location of so important a work, and the estimates, of which only a summary is here given, embraced as close a classification of the material to be excavated as could be made in advance of actual construction. The prices ranged from a minimum of 12 cents per cubic yard for earth to a maximum of 90 cents for solid rock in open cuts. The estimates for tunneling ranged from $10 to $25 per foot. So far as could be judged, the material to be encountered in the tunnels is nearly all comparatively soft rock, but, as evidenced by tunnels already in existence through similar material, is of such character that it would rarely require timbering or other support. In making up the estimates an allowance of 15 per cent was made in all cases for engineering and contingencies. Following is the estimate of cost of this canal system, being a slight modification of that made in 1892, to fit somewhat altered conditions:

Estimate of cost of proposed Truckee River Highline canal, branch canals, and distributing ditches.

Main canal:		
Dam and regulating gates	$10,000	
Canal excavation	216,000	
Nine tunnels, 8,312 feet	117,000	
Flumes, 5,000 M feet B. M., at $28	140,000	
Dog Valley Creek inverted siphon, 1,700 feet	27,000	
		$510,000
Branch canal No. 1		46,000
Branch canal No. 2		104,000
Minor distributing ditches		90,000
Total		750,000

The cost per acre for delivering water to 75,000 acres of land is $10.

LOWER TRUCKEE CANAL.

The Lower Truckee canal line, surveyed by the engineers of the United States Irrigation Survey in 1889–90, and already referred to, was designed to take water from near the crest of a dam across the river and about 50 feet above its bed. The location of this proposed dam is about 3 miles below Clarks station, on the Central Pacific Railroad. In order to obviate the necessity for this high dam, which would be very expensive, and yet gain the required elevation to command all of the irrigable lands, the writer proposes a canal to head in the right bank of the river a short distance above Clarks station, about 4 miles, by the canal route, westerly from the site of the dam

first mentioned; from that point the line to follow along the mountain side, close to the river, for a distance of about 10 miles, to a point approximately 5 miles above the town of Wadsworth, where it would divide into two main branches, designated A and B. Up to that point the main canal would have a uniform grade of 0.4 in 1,000, a sectional area of 205 square feet, and a carrying capacity of 750 second-feet.

Branch canal A, designed to supply the lands southeast of Wadsworth, to continue along the mountain side to the south of the river for about 7 miles, to a point east of south from Wadsworth, where it would enter the plain; thence to run in an easterly direction about 13 miles, to the edge of Carson Sink Valley. This line was run on a grade of 0.4 in 1,000, the canal to have a sectional area of 160 square feet and a capacity of 525 second-feet for the first 10 miles, after which its sectional area and carrying capacity would diminish as lateral ditches branch off from it.

Branch canal B would run northward from the terminus of the main canal, crossing Truckee River by an inverted siphon 66 inches in diameter, and extending to Pyramid Lake. It would have a total length of about 24 miles, and would furnish water to about 24,000 acres of land lying west and north of Wadsworth. Except in the pipe line across the river, where the hydraulic grade is 3 in 1,000, this line is designed to be run on a uniform grade of 0.3 in 1,000. The sectional area and capacity at the head are 90 square feet and 225 second-feet, respectively, but these would be gradually diminished to the north.

The main distributing canals would be entirely in earth and cheap of construction. While no surveys have been made to furnish data for an estimate of their cost, it is believed that it will not exceed 80 cents to the acre of irrigable land.

The following preliminary estimate of the cost of the canal system has been prepared:

Estimate of cost of proposed Lower Truckee canal system.

10 miles of main canal, with headworks	$144,000
Branch canal A, 20 miles	120,000
Branch canal B, 24 miles	52,000
Inverted siphon of branch canal B	20,000
Minor distributing canals	80,000
Total	416,000

Engineering and contingencies are provided for in this estimate, as in that of the Highline canal.

POSSIBLE USES OF WATER FOR POWER DEVELOPMENT.

It has been shown that the minimum discharge of Truckee River at Truckee can be maintained at 110 second-feet and at Floriston at 300 second-feet, the tributary streams entering between the two points (the principal of which is the Little Truckee, at Boco) helping to make

up the greater volume. Below Floriston there are a number of small streams entering the river, which will still further increase its flow, so that the discharge will probably never fall below 300 second-feet between Floriston and the head of the Highland ditch, about 1½ miles below Verdi. From that point to Reno an average minimum flow of not less than 250 cubic feet per second can be relied upon, for not more than 50 second-feet will be required by the intervening irrigation canals during the low-water periods. Below Reno, as far as Vista, the grade being comparatively light, no estimate of power possibilities will be made. From Vista to Clarks station the minimum discharge of the river will probably be in excess of 300 second-feet, but that volume is taken in order to be on the side of safety. On this basis the following table, which fairly exhibits the possibilities for power development on Truckee River, has been prepared:

Possible power development on Truckee River.

Between—	Distance.	Minimum water supply.	Total fall.	Available fall.	Actual power, 80 per cent of theoretic.
	Miles.	*Sec.-ft.*	*Feet.*	*Feet.*	*H. P.*
Truckee and Boca	9.0	110	300	250	2,500
Boca and Floriston	4.5	250	200	150	3,400
Floriston and Mystic	2.0	300	143	136	*a* 3,700
Mystic and Highland ditch	19.5	300	410	300	*b* 8,200
Highland ditch and Reno	10.0	250	280	220	*b* 5,000
Vista and Clarks station	12.0	300	250	180	4,900
Total					27,700
Power now utilized between above points					4,100
Total possible and undeveloped					23,600

a Utilized. *b* Two hundred horsepower utilized.

NECESSITY FOR NATIONAL CONTROL OF WATER.

Since almost the entire water supply of Truckee River comes from the upper portion of the basin, the major part of which is in California, and the irrigable lands are all in the lower portion, within the State of Nevada, it follows that the users of the water for irrigation purposes can never have entire control of the source of their supply, though such control is vital to the ultimate prosperity, and it may be said to the very existence, of communities dependent upon irrigation. If the irrigation of these lands be undertaken by private enterprise or by the State of Nevada, it is certain that sooner or later interstate complications will arise which may result in at least the partial destruction of all that may be accomplished. It is a problem, therefore, with which the National Government only is competent to cope. So it is recommended that the entire upper portion of the Truckee Basin be segregated into a national forest and water reserve and the waters be dedicated to industrial and irrigation purposes within the basin and upon such lands immediately adjacent thereto as can be supplied.

GENERAL CONCLUSIONS AND RECOMMENDATIONS.

(1) It is feasible to construct in the upper portion of the Truckee Basin seven storage reservoirs with gross and net capacities as follows:

Cost and capacities of proposed reservoirs in the Truckee Basin.

Name of reservoir.	Gross capacity.	Net capacity (can be drawn annually).	Cost, complete.
	Acre-feet.	*Acre-feet.*	
Lake Tahoe	745,400	200,000	$49,731
Donner Lake	26,900	26,900	86,746
Independence Lake	11,725	11,725	33,979
Twin Valley	7,818	7,818	41,195
Little Truckee	20,540	20,540	61,820
Henness Pass	17,000	16,000	47,575
Dog Valley	5,785	5,785	32,186
Total	835,168	288,768	353,232

(2) The watersheds tributary to the reservoirs mentioned yield sufficient water, even in seasons of minimum precipitation, as that of 1899 and 1909, to fill each of them.

(3) The water stored in the reservoirs mentioned, if employed to supplement the ordinary flow of Truckee River and used with moderate economy, is sufficient, even in dry years, to irrigate 185,116 acres of land in excess of that now watered, or a total of 219,000 acres, and maintain the minimum discharge of Truckee River at 300 cubic feet per second above Reno and Clarks station.

(4) It is feasible, by utilizing the foregoing minimum discharge of Truckee River, to develop between Truckee and the head of the Lower Truckee canal at Clarks station over 20,000 horsepower in excess of that now developed.

(5) It is feasible to construct an irrigating canal having a capacity of 550 second-feet, leading from Truckee River near Floriston, Cal., to supply 75,000 acres of arable lands above and to the north and east of Reno, at a cost, including headworks and the main branches and distributaries, of $750,000.

(6) It is feasible to construct a canal having a capacity of 750 cubic feet per second on the south side of Truckee River from above Clarks station to a short distance above Wadsworth, where a branch with 225 second-feet capacity can be taken across the river by pressure pipes and be led northward toward Pyramid Lake, while the main branch, with a capacity of 525 second-feet, can be continued to the southeast and east of Wadsworth, the two branches supplying water to 99,000 acres of land, about 30,000 acres of which are in the Truckee River Basin (more than 20,000 acres of this being in the Pyramid Lake Indian Reservation) and 69,000 acres in the basin of Carson River (approximately 50,000 acres of this being in the Carson Sink Valley); and the cost of this canal system, including the principal distributing branches, will probably be about $4.20 for each acre commanded, or a total of $416,000.

(7) The entire upper portion of the Truckee River Basin, embracing all of the drainage area above the town of Verdi, and the north and east slopes of the Tahoe Range, should be set aside as a forest and water reserve or a national park.

(8) The Lake Tahoe dam should be built as the first step in the storage of water on the Truckee, and all private rights in the other reservoir sites described should be acquired by the Government, so that when the time for their utilization arrives there will be no obstacles in the way of their construction.

(9) The portion of the public domain which can be irrigated from the stored waters of Truckee River should be withdrawn from entry, and after being provided with a system of canals for the delivery of water should be offered for sale at a price commensurate with the cost of their reclamation as irrigable lands with water rights.

(10) Measurements of stream discharge and evaporation in the basin of the Truckee should be continued at important points, to supply more complete and reliable data on the water supply.

FINANCIAL SUMMARY.

Summarizing, the estimated cost of the projected storage works is as follows:

Summary of cost of storage works.

Seven reservoirs	$353,232
Truckee River Highline canal system	750,000
Lower Truckee canal system	416,000
Total	1,519,232

There are 185,116 acres of land, public and private, which would be irrigated by these works in addition to the area already watered. Assuming that 7,116 acres, or 7,616 acres including the 500 acres already under irrigation, be irrigated for the Piute Indians—an area believed to be ample for the sustenance of that tribe without cost to the Government—there remain 178,000 acres to sustain the cost of these irrigation works, making the necessary charge per acre for water rights $8.50. It is believed that these water rights and the remaining public lands could be sold at that rate within a very few years. The actual value of 178,000 acres of land with water rights would be not less than $30 an acre, or a total of $5,340,000. The increase in the value of town property which would necessarily follow, and the value of the water power made available, all of which would be without expense to the public, can not here be estimated.

While the construction of the Lake Tahoe dam is recommended as the first step in the storage of water on the Truckee, it must not be forgotten that in order to utilize the stored waters a system of main canals, costing not less than $416,000 for one or $750,000 for the other, must first be provided, and that without such canals to deliver the water to irrigable lands the construction of the Tahoe or any other reservoir is useless.

INDEX.

Page.

Alder Creek, discharge of 17, 32
drainage area of 16
Blackwood Creek, discharge of 33
Boca, Cal., discharge measurements near. 21–22
rainfall at 11, 12
Boca reservoir site, map of 64
objections to 42
Canals, surveys, and plans for 38–39, 81–84
Carson, Nev., rainfall at 11, 14
Cascade Creek, discharge of 33
Cold Creek, discharge of 17, 32
Cold and Donner creeks, drainage area of. 16
Dams in Truckee River, plates showing .. 42, 72
Deer Creek, discharge of 32
Dog Valley, dam site in, profile of 70
reservoir in, survey and plans for 69–71
reservoir site in, map of 69
Dog Valley Creek, discharge of 17, 32
drainage area of 16
Donner Creek, discharge of 17, 32
Donner and Cold creeks, drainage area of. 16
Donner Lake, dam site at, profile of 54
reservoir at, survey and plans for 51–55
reservoir site at, map of 52
view of, plate showing 50
water storage in basin of, projects for 37
Drainage areas, estimate of 15–16
Elevation, increase of rainfall with 15
Emerald Bay, view from, plate showing. 42
Emerald Bay Creek, discharge of 33
Essex, Nev., Truckee River at, discharge of 18, 22
Evaporation, measurements of 34–36
Floriston, Cal., flume near, plate showing headworks of 74
water used near 73
Floriston Pulp and Paper Company, dam of, plate showing 72
water used by 72
Flume of Truckee River, General Electric Company, plate showing. 74
General Creek, discharge of 33
Genoa, Nev., rainfall at 11, 14
Glenbrook, Nev., rainfall at 15
Glenbrook Creek, discharge of 33
Grass Lake reservoir site, objections to .. 40
Hacker, M., work of 81
Hall, W. H., work of 36
Henness Pass Valley, dam site in, map of. 68
reservoir at, surveys and plans for .. 66–68
reservoir site and supply canal at, map of 67
Hot Springs Creek, discharge of 33
Hunter Creek, discharge of 32
drainage area of 16

Page.

Independence Lake, dam site at, profile of 57
reservoir at, survey and plans for. 37, 56–58
reservoir site at, map of 56
Irrigable lands, area of 77–78
duty of water on 79–80
ownership of 78–79
water required and available 80–81
Irrigating ditches, flow of 76
Irrigation, water used for 74–77
Irrigation canals in Truckee Basin, maps showing 74, 75
Joe Gray Creek, discharge of 17, 32
drainage area of 16
Juniper Creek, discharge of 17, 32
drainage area of 16
Lake Tahoe, dam at, plate showing 42
dam site of, map of 48
discharge of 47
drainage area of 16
evaporation in 34–35
fluctuations of 45–47
map of 44
measurements of Truckee River at outlet of 17
reservoir at, survey and plans for 43–51
streams flowing into, discharge of 33
utilization of waters of, projects for .. 37
views of, plates showing 10, 42
Lewers's ranch, Nevada, rainfall at 11, 13
Little Truckee River, discharge of 21, 32
drainage area of 16
falls of, plate showing 50
Little Truckee reservoir, map of 61
dam site of, map of 62
survey and plans for 61–66
Little Valley reservoir site, objections to. 43
Lower Truckee canal, survey and plans for 83–84
McKinney Creek, discharge of 33
Marlette Lake, Nev., rainfall at 14
Martis Creek, discharge of 17, 32
drainage area of 16
reservoir site at, objections to 43
Meiggs Creek, discharge of 33
Monument Peak reservoir site, objections to 40
Mystic, Cal., flume near, plate showing .. 72
power house at, plate showing 76
National control of water, necessity for .. 85
Newell, F. H., letter of transmittal by ... 7
Newlands, F. G., reference to 52
North Fork of Prosser Creek, reservoir on. *See* Twin Valley reservoir.
Power, possible uses of water for 84–85
use of water for 72–74

Page.
Power house of Truckee River General Electric Company, plate showing ... 76
Precipitation. *See* Rainfall.
Prosser Creek, discharge of ... 21, 32
drainage area of ... 16
Prosser Creek reservoir. *See* Twin Valley reservoir.
Pyramid and Winnemucca lakes, evaporation from ... 36
Rainfall, increase of, with elevation ... 15
records of ... 10–15
Reno, Nev., evaporation at, measurements of ... 35–36
rainfall at ... 11, 12
Truckee River at, plate showing ... 32
water used near ... 73
Reno Electric Light and Power Company, water used by ... 73
Reno reduction works, water used by ... 73
Reservoir sites, surveys of ... 36–38, 39–71
Riverside flour mill, water used by ... 73
Rubicon Creek, discharge of ... 33
Run-off and stream flow, measurements of ... 16–33
Sardine Valley reservoir site, objections to ... 43
Spooner Creek, discharge of ... 33
Squaw Creek, discharge of ... 32
drainage area of ... 16
Squaw Valley, dam site in, map of ... 42
reservoir site in, map of ... 42
objections to ... 42
Stampede Valley reservoir site, objections to ... 40
Stateline Mills, Cal., Truckee River at, discharge of ... 19, 26–28
Truckee River at, plate showing ... 18
Steamboat Creek, discharge of ... 21
drainage area of ... 16
Steamboat Springs, Nev., Steamboat Creek at, discharge of ... 21
Stewart, T. K., work of ... 55, 81
Stream flow and run-off, measurements of ... 16–33
Summit, Cal., rainfall at ... 11, 13
Tahoe, Cal., evaporation at ... 34
Truckee River at, discharge of ... 19, 23–25
Tahoe, Lake, basin of, drainage area of ... 16
dam at, plate showing ... 42
dam site of, map of ... 48
discharge of ... 47
drainage area of ... 16
evaporation in ... 34–35
fluctuations of ... 45–47
map of ... 44

Page.
Tahoe, Lake, measurements of Truckee River at outlet of ... 17
reservoir at, survey and plans for ... 43–51
streams flowing into, discharge of ... 33
utilization of waters of, projects for ... 37
views of, plates showing ... 10, 42
Taylor Creek, discharge of ... 33
Trout Creek, discharge of ... 33
Truckee, Cal., rainfall at ... 11, 13
water used at ... 72
Truckee Basin, map of ... 9
irrigation canals in, maps showing ... 74, 75
Truckee Lumber Company, water used by ... 72
Truckee River, course of ... 10
dams on, plates showing ... 42, 72
drainage area of ... 16
Highline canal on, survey and plans for ... 81–83
measurements of ... 17–32
tributaries of, discharge of ... 17, 32
views of, plates showing ... 18, 32, 42, 50, 72
Truckee River General Electric Company, flume of, plate showing ... 74
power house of, plate showing ... 76
water used by ... 73
Twin Valley reservoir, survey and plans for ... 59–61
Twin Valley reservoir and dam sites, maps of ... 59
Virginia, Nev., rainfall at ... 11, 14
Vista, Nev., Truckee River at, discharge of ... 20, 22–23, 29–31
Truckee River at, plate showing ... 18
Verdi, Nev., rainfall at ... 11, 12
water used near ... 73
Verdi Mill Company, water used by ... 73
Wadsworth, Nev., rainfall at ... 11
water used near ... 73
Wadsworth Light and Power Company, water used by ... 73
Ward Creek, discharge of ... 33
Water, duty of ... 79–80
national control of, necessity for ... 85
possible uses of, for power development ... 84–85
present use of and existing water rights ... 72–77
quantity required and available for irrigation ... 80–81
Webber Lake, map of and profile of dam site ... 41
reservoir at, objections to ... 40–42
plans for ... 37
Winnemucca and Pyramid lakes, evaporation from ... 36

O

I 19.13

DEPARTMENT OF THE INTERIOR

GOVERNMENT PUBLICATIONS CLEMSON LIBRARY

WATER-SUPPLY

AND

IRRIGATION PAPERS

OF THE

UNITED STATES GEOLOGICAL SURVEY

Clemson College Library

No. 69

WASHINGTON
GOVERNMENT PRINTING OFFICE
1902

UNITED STATES GEOLOGICAL SURVEY
CHARLES D. WALCOTT, DIRECTOR

WATER POWERS

OF THE

STATE OF MAINE

BY

HENRY ALBERT PRESSEY

WASHINGTON
GOVERNMENT PRINTING OFFICE
1902

CONTENTS.

	Page.
Letter of transmittal	9
Introduction	11
Geology	12
Introductory	12
Pre-Pleistocene history	13
Pleistocene history	13
Forests	15
Hydrography	16
General features	16
St. Croix River	20
Drainage basin	20
Lake storage	21
Water powers	23
West Branch of St. Croix River	27
Penobscot River	27
Drainage basin	27
Lake storage	29
Control of storage at Twin dam	30
Water powers	30
Artificial connection between the St. John and Penobscot rivers	36
Flow	36
Kennebec River	38
Drainage basin	38
Lake storage	40
Water powers	42
Flow	45
Tributaries of Moosehead Lake and Kennebec River	57
Roach River	57
Moose River	57
Tomhegan and Socatean rivers	58
Dead River	58
Sandy River	58
Carrabassett River	58
Sebasticook River	59
Messalonskee River	59
Cobbosseecontee River	59
Androscoggin River	70
Drainage basin	70
Lake storage	71
Water powers	72
Flow	76
Little Androscoggin River	91
Presumpscot River	91

Hydrography—Continued. Page.
Saco River 105
Drainage basin 105
Lake storage 105
Water powers 106
St. John River 109
Drainage basin 109
Lake storage 110
Water powers 110
Tributaries of St. John River 111
Meduxnikeag and Presque Isle rivers 111
Aroostook River 111
Fish River 111
Alleguash River 111
St. Francis River 112
Upper St. John River 112
Coastal streams 112
Narraguagus River 112
East Machias and West Machias rivers 113
Dennys, Pemaquan, and other rivers 114
Union River 114
St. George, Sheepscot, Medomac, and Damariscotta rivers 115
Mousam and Kennebunk rivers 116
Piscataqua River 116
Tidal powers 117
Summary 117
Index 121

ILLUSTRATIONS.

		Page.
PLATE I.	Map of Maine, showing drainage basins	12
II.	*A*, Typical forest stream of Maine; *B*, View in lake and forest region	14
III.	Drainage basin of St. Croix River	20
IV.	*A*, Upper pitch of the Spragues Falls, St. Croix River; *B*, Salmon Falls and mill of Canadian Cotton Mills Company, St. Stephen, New Brunswick	26
V.	Drainage basins of Penobscot and Kennebec rivers	28
VI.	Great arches at Ripogenus, below Chesuncook Lake, Penobscot River	30
VII.	*A*, Head gates at east outlet of Moosehead Lake; *B*, West outlet of Moosehead Lake	40
VIII.	*A*, Log boom on Kennebec River above Madison Falls; *B*, Cotton mills of Edwards Manufacturing Company, at Augusta	44
IX.	*A*, Falls on Carrabassett River, North Anson; *B*, Falls on Messalonskee River at Oakland	58
X.	Drainage basins of Androscoggin, Presumpscot, and Saco rivers	70
XI.	Upper and lower dams at Rumford Falls	72
XII.	*A*, Upper dam at Rumford Falls; *B*, Lower dam at Rumford Falls, at entrance to middle-level canal	74
XIII.	*A*, Rumford Falls, looking downstream toward middle-level canal; *B*, Saco River below Salmon Falls dam	76
XIV.	Great Falls on Saco River, at Hiram	106
FIG. 1.	Discharge of Kennebec River at Waterville, Me., 1893 and 1894	52
2.	Discharge of Kennebec River at Waterville, Me., 1895 and 1896	53
3.	Discharge of Kennebec River at Waterville, Me., 1897	54
4.	Discharge of Kennebec River at Waterville, Me., 1898 and 1899	55
5.	Discharge of Kennebec River at Waterville, Me., 1900	56
6.	Discharge of Cobbosseecontee River at upper dam near Augusta, Me., 1890 to 1899	65
7.	Discharge of Cobbosseecontee River at upper dam near Augusta, Me., 1900	66
8.	Discharge of Androscoggin River at Rumford Falls, Me., 1892 and 1893	85
9.	Discharge of Androscoggin River at Rumford Falls, Me., 1894 and 1895	86
10.	Discharge of Androscoggin River at Rumford Falls, Me., 1896 to 1898	88
11.	Discharge of Androscoggin River at Rumford Falls, Me., 1899	89
12.	Discharge of Androscoggin River at Rumford Falls, Me., 1900	90

LETTER OF TRANSMITTAL.

DEPARTMENT OF THE INTERIOR,
UNITED STATES GEOLOGICAL SURVEY,
DIVISION OF HYDROGRAPHY,
Washington, D. C., April 11, 1902.

SIR: I have the honor to transmit herewith a manuscript prepared by Mr. H. A. Pressey, on the water powers of the State of Maine, and to request that it be published in the series of Water-Supply and Irrigation Papers. For a number of years data concerning the streams of this State have been collecting in this division, largely through the courtesy of engineers in charge of water-power-development projects, and there has been a steadily increasing demand for a more complete study of the conditions. This culminated in an offer of cooperation in field work, made semiofficially through Mr. W. T. Haines (of the governor's council), of Waterville, Me., and as a consequence active field work was begun in the year 1901. In order to obtain a full grasp of the problem, and to provide a guide for future operations, as well as to give immediate information of what is already known, Mr. Pressey has brought together in compact form the data obtained from various sources, and presents them herewith. It is planned to supplement this report by annual or periodical statements of the flow of the streams and the developments which have taken place, pointing out at the same time the opportunities for an increased employment of water in various industries.

Very respectfully,

F. H. NEWELL,
Hydrographer in Charge.

Hon. CHARLES D. WALCOTT,
Director United States Geological Survey.

WATER POWERS OF THE STATE OF MAINE.

By Henry A. Pressey.

INTRODUCTION.

Two great resources of the State of Maine stand preeminent: (1) Its water powers, which are unrivaled in the United States, and (2) its forests, which still cover vast areas. It seems remarkable that so little has been done to study or protect either of these. The value of hydrographic investigations for ascertaining knowledge of the fall and flow of streams and of the possibilities of increased storage of water has been recognized by many States of the Union as well as by the National Government. Many of the States are now cooperating with the Government, through the United States Geological Survey, in the study of their water resources, and within the last few years investigation of forest conditions has been placed upon a scientific basis, and great strides have been made toward a betterment of conditions in and the preservation of the forest lands throughout the country.

Many years ago it was prophesied of Maine that "as its industries develop its water power must receive increased attention." Up to this time, however, the studies of its water-power resources have been meager and incomplete.

The report by Walter Wells on the water power of the State, made in accordance with an act of the State legislature, and published in 1869, was an excellent contribution to the available knowledge on the subject. In Volume XVI of the Tenth United States Census (1880) Prof. George F. Swain described with much detail the water powers of the State, and in the Nineteenth Annual Report of the United States Geological Survey, Part IV, published in 1899, Prof Dwight Porter brought the data down to that year, adding much that was new. No actual measurements, however, of either the fall or the flow of the streams were made for these reports, which were compilations of data gathered from widely scattered sources, supplemented by estimates based thereon. Although these reports were of great value, they should be extended and supplemented by investigations in the field, by measurements of flow, fall, and precipitation, and by studies of the possibilities of increasing the lake storage. Information in regard to the flow of the streams is available in only a few

cases, and in those cases only because of the individual efforts of water-power owners.

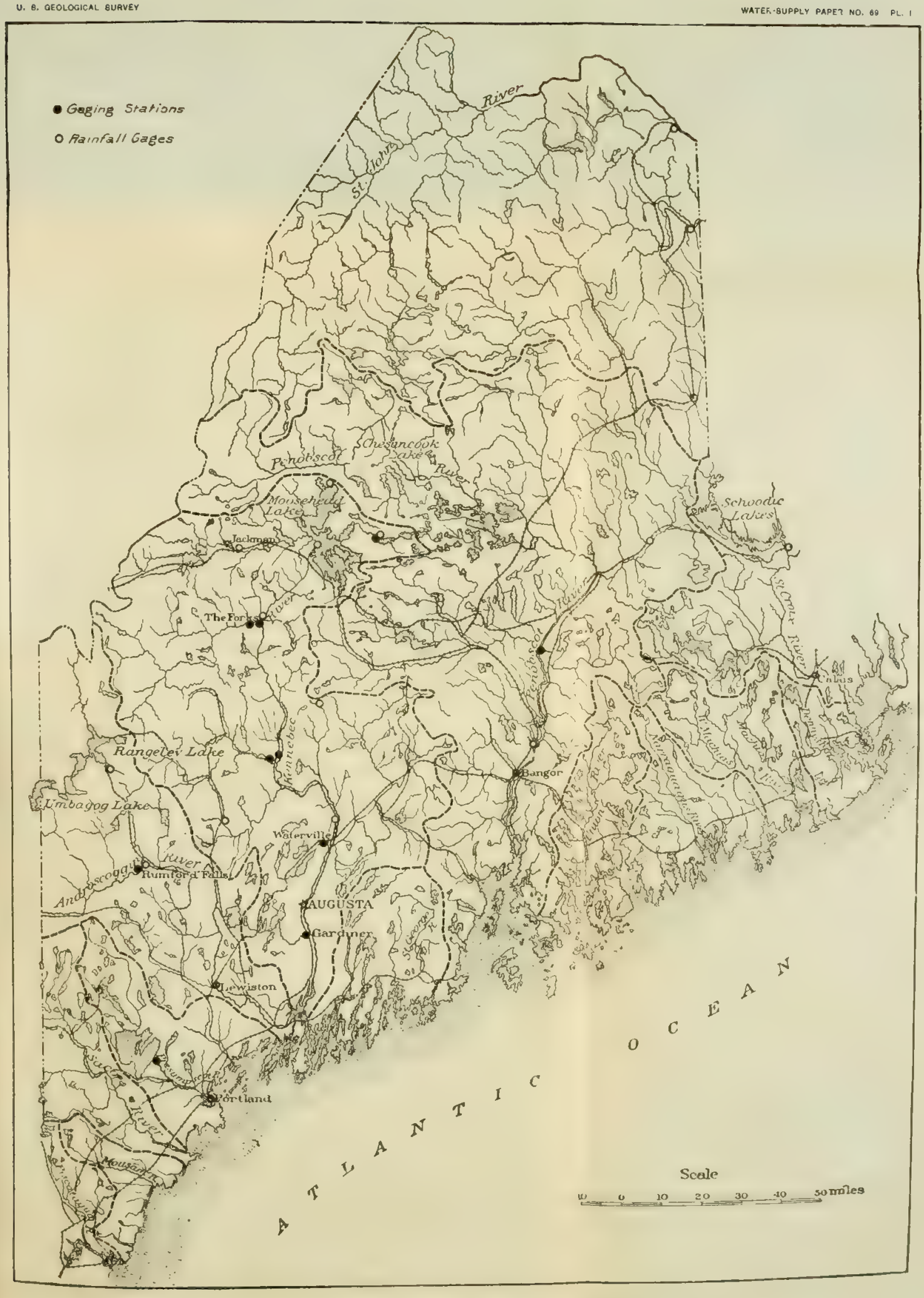
With the object, therefore, of acquiring more definite information regarding the water resources of the State, and at the solicitation and with the cooperation of a number of the mill owners, in the summer of 1901 the United States Geological Survey commenced a hydrographic investigation of Maine. Stations were established on several of the large rivers and their tributaries—at The Forks and at North Anson on the Kennebec, at The Forks on Dead River, at North Anson on Carrabassett River, at Roach River on Roach River, and at Montague on Penobscot River—and additional rain gages were placed in the upper parts of the drainage basins—at The Forks, at Roach River, at Northeast Carry, at Jackman, and at Wytopitlock. This work is preliminary to more complete studies in the near future, and the following paper has been written with the idea of assembling such facts as are known in regard to the rivers. Much of the material has been taken largely from the publications mentioned, and quotations of whole paragraphs have been made whenever thought desirable. An attempt has been made to bring the data down to date, and the latest obtainable information as to power developed, fall, etc., has been inserted in the descriptions of the various streams. It is expected that during the summer of 1902 the investigations will be greatly extended. Descriptions of the stations recently established by the Survey will be found in Water-Supply Paper No. 75.

The writer is indebted to Mr. George Otis Smith, a geologist of the United States Geological Survey, for the sketch of the geology of the State.

GEOLOGY.

Introductory.—Geologic conditions greatly influence the water resources of such a region as the State of Maine. The present configuration of the surface and the rock and soil composing and underlying that surface are the product of past processes, the record of which constitutes the geologic history of the area.

For the purposes of a brief discussion of these conditions, which directly affect the water powers of the State and their availability and permanence as a factor in industrial activity, the geologic history of the State may be divided into two parts, the first covering pre-Pleistocene time and the second the Pleistocene period. These two time divisions differ greatly in length, but not greatly in their bearing upon the water powers. The pre-Pleistocene comprises all time down to the early Glacial epoch, while the Pleistocene includes the time when a glacial ice cap covered the whole area of the State, as well as the following final retreat of the ice and general subsidence of the land. To the pre-Pleistocene belong the geologic processes which produced the rocks from which the present surface has been



MAP OF MAINE SHOWING DRAINAGE BASINS

carved; to the Pleistocene belong the activities by which this surface has been in large part modeled.

Pre-Pleistocene history.—Exact knowledge of the geology of the State is confined to a few localities, where the rock formations have been studied in detail and their relations and age have been determined. A considerable area of fossiliferous sandstones, shales, and limestones in the northern part of Somerset and Aroostook counties has been shown to be of Silurian and Devonian age, and with these Paleozoic sedimentary rocks in Aroostook County are associated volcanic rocks.[a] In the central portion of the State the roofing slates of Monson, Brownville, and other localities cover large areas. Other argillaceous rocks, such as shales and schists, occur extensively, and impure limestones and calcareous sandstones are common. The abundance of granite and allied igneous rocks in the central and southern portions of the State is evidenced by the many localities where these rocks are quarried for local use and for shipment to other States. On the coast granite, gneiss, and schists of various kinds occur, associated with limestone and other sedimentary rocks at several places.

A noticeable characteristic of the rocks mentioned as exposed in this area is their compactness and hardness. In general, this may be attributed to their age, most of them dating back probably to the Paleozoic, and some perhaps to earlier periods. A more important factor than mere age, however, is the alteration that the rocks have undergone. In the ages which have elapsed since their deposition they have experienced many changes, by which soft shales have been metamorphosed into crumpled schists, and friable sandstones into flint-like quartzites. The intrusion of large masses of molten granite has doubtless effected some of these changes in the surrounding rocks, and the folding and elevating of the horizontal beds into mountain ranges has been no less effective in the work of induration. The processes of erosion have laid bare the bases of these mountains, which can be seen along almost every river bank, in the closely folded strata that so effectually withstand the attacks of the rushing water.

In a word, then, the State is favored with rocks of a hardness sufficient to make the present channels of the streams permanent, while the complicated structure of the rocks and the consequent alternations of beds relatively hard and soft are the cause of some of the abrupt changes in the grade of the rivers whereby falls and rips succeed quiet reaches.

Pleistocene history.—As in the preceding section, the results of the geologic processes rather than the processes themselves will be considered here. The history of the advance of the ice cap southward over the State and the climatic conditions favoring this glacial occu-

[a] Contributions to the geology of Maine, by H. S. Williams and H. E. Gregory: Bull. U. S. Geol. Survey No. 165, 1900.

pation, and then of the retreat of the ice and the changes in elevation of the land surface, are topics of interesting research, but here it will be sufficient to note the differences between the region at the beginning of this period and at its close.

At the time of the first invasion of the ice the topography of the State was probably not widely different from that of to-day. Perhaps the hills rose more abruptly above the valleys, and the larger rivers may have meandered over wide valley floors instead of being confined between terraces. In such valleys bare rock was doubtless of rare occurrence, and everywhere the soil resembled more that found to-day in the Southern States than the gravels, sands, and clays of Maine.

The first result of the occupation of this area by an ice sheet was the cutting away of the decomposed rock and the smoothing down of the outlines of the hills and mountains. So it is that to-day expensive structures can safely be erected along the banks of the rivers close to the water powers, the firm rock foundation affording security against damage by freshet.

The rock and soil detritus produced by glacial erosion furnished in turn the material for glacial deposits. Streams flowing over the ice, under the ice, and later away from the melting ice front, transported great masses of sand and gravel, as well as fine silt, and deposited them along their courses. During the later stages of the Glacial epoch subsidence of the land caused the sea to advance inland along the principal valleys. The glacial streams thus entered quiet water and deposited their loads in what are now the upper valleys, a hundred miles or more from the sea.[a] These deposits assumed various forms, and thus originated much of the topography familiar to the residents of the State. But such extensive deposits affect more than the scenery of a region. The drainage system of Maine was greatly altered. Old channels were filled with glacial gravels, and the streams, their volume and energy greatly increased by the melting of the glacier, cut new channels. In such a case a river might abandon an old wide valley, possessing a moderate grade well established, and cut across a rock ridge, developing a waterfall. When the history of the rivers of this region is worked out, there will be found many illustrations of diversions which resulted in the development of valuable water powers.

A hardly less important result of the glaciation of Maine are the numerous lakes and ponds so characteristic of almost every portion of the State. The pond region between Sandy River and the Kennebec in Somerset and Kennebec counties is typical. The total area of water surface is great, and the connecting and tributary streams are so erratic in their courses as at once to suggest that the original sys-

[a] The glacial deposits of the State are elaborately described by Prof. George H. Stone in Monograph XXXIV of the United States Geological Survey, 1899.

A. TYPICAL FOREST STREAM OF MAINE.

B. VIEW IN LAKE AND FOREST REGION.

tem of drainage has been so modified as hardly to be recognizable. These conditions are extremely important in their economic bearing, for the ponds and lakes, together with the swamps, constitute a vast storage system which holds the water supply in reserve, and the very indirect communication which many of these natural storage reservoirs have with the rivers serves to hold back somewhat the water in times of freshet. As is well known, it is these drainage modifications, which are directly referable to the glacial occupation, that make the water powers of New England so vastly superior to those of the South Atlantic States.

The present is a period of apparent equilibrium and quiet so far as geologic processes are concerned, yet in reality this may not be the case, so silent and slow moving are these natural forces.

FORESTS.

Nearly the whole of Maine was originally covered with forests. The area of the State is 33,040 square miles, of which 3,145 square miles are water surface, leaving a land surface of 29,895 square miles. Of the latter 9,000 square miles are in farms, leaving about 20,000 square miles in an uncultivated state, largely a wilderness. It has been stated that 2,400 square miles included as farm lands consist of woods. Adding this to the area in wilderness, we have 21,200 square miles of woodland in the State, a territory equal to the combined areas of Massachusetts, New Hampshire, and Connecticut. It will be seen that, despite the extensive cutting that has been done in Maine during the last fifty years, there yet remain vast areas of timber land. A large part, perhaps half, of the area in woods is not available for lumbering, owing to the poor condition of the timber. Pine was formerly the chief tree of the State, but by continued cutting the supply of that timber has been greatly reduced. Spruce, hemlock, fir, maple, beech, oak, birch, basswood, cedar, and poplar, however, grow abundantly and furnish excellent material for the lumberman and the manufacturer. A view of a typical forest of the State is shown in Pl. II.

The lumber industry has been for many years one of the most important in the State, and recently the manufacture of pulp and paper has assumed a position in the front rank. It is said that the entire cut of lumber in the State for the last fifty years has been not less than 25,000,000,000 feet. During 1900 the cut was 784,647,000 feet B. M.,[a] and this is likely to increase. Of this amount 350,000,000 feet of spruce is used yearly by the pulp and paper mills, while most of the remainder is sold as lumber. At the present time there are in the State 30 pulp mills and 29 paper mills. The total amount of capital invested in them exceeds $30,000,000,

[a] United States Census report.

and the total value of the annual product is about $18,000,000. The amount paid in wages is more than $5,000,000 annually, and the amount paid for wood more than $2,500,000 annually.

Most of the valuable timber trees are of slow growth. It is likely that the growth of timber in the State aggregates between 600,000,000 and 700,000,000 feet each year, so that at the present rate of cutting the forests are nearly holding their own. By systematic cutting under forestry regulations, however, the yield of the timber lands could be greatly increased and the young growth be so preserved and fostered that the yearly output would be materially augmented. It is hoped that in the near future those interested in the forests of the State—the lumbermen, the manufacturers, and the State officials—will see the wisdom of employing trained foresters to superintend the lumbering operations, for the figures given show, without further comment, the importance of both water power and forests to the two chief industries of the State, and the development of the water powers and the preservation of the forests are so closely associated that they can not well be separated.

HYDROGRAPHY.

GENERAL FEATURES.

No other tract of country of the same extent on the continent is so well watered—supplied with lakes and streams well distributed—as is Maine. There are five principal lake chains or systems—i. e., large lakes connected by rivers and discharging into main channels which convey their accumulated waters to the ocean. These are, beginning on the western boundary, (1) the Umbagog-Rangeley series, with an area of 90 or more square miles, drained by Androscoggin River; (2) the Moosehead series, forming the headwaters of Kennebec River, the main lake of which is 120 square miles in area, and is the largest inland body of water in New England; (3) the Penobscot series, consisting of Chesuncook and its surrounding lakes on the West Branch of the Penobscot, Alleguash, Chamberlain, and others on the East Branch, and the Seboeis and others connected with it still farther east but flowing into the East Branch of the Penobscot; (4) the Schoodic Lakes, in the southeastern part of the State, drained by St. Croix River; and (5) the many lakes forming the headwaters of St. John River and its tributaries. There are many other lakes in every county, which, though of small area, in the aggregate hold an immense amount of storage water and add much to the importance of the lake systems of the State.

The total number of lakes, not including small ponds tributary to the rivers, is 1,620, and their aggregate area 2,300 square miles, making one lake to each 20 square miles of territory and one square mile of lake surface to each 14.3 square miles of land surface. The following

table gives the names of the lake systems and interesting facts regarding them:

Lake systems of Maine.

Name of system.	Number of lakes.	Aggregate area.	Ratio of lake surface to basin surface.	Average area of lakes.
		Sq. miles.		*Sq. miles.*
Saco	109	84	1:16.6	0.75
Androscoggin	148	313	1:17	1.43
Kennebec	311	450	1:12.9	1.44
Penobscot	467	585	1:14	1.25
St. Croix	61	150	1: 6.5	2.95
St. John	206	350	1:21.1	1.75
Dennys, etc	22	38	1: 9.8	1.72
Machias, East and West	56	68	1:11.7	1.29
Narraguagus	38	25	1:22	0.65
Union (not including islands)	43	60	1: 8	1.39
St. George, Sheepscot, etc	72	50	1:16	0.70
Presumpscot	45	97	1: 5.3	2.10
Royal, etc	6	4	1:42	0.66
Mousam	14	10	1:26	0.71
Piscataqua	22	16	1:34	0.72
Total	1,620	2,300		

The lakes of the larger systems are in the mountain region, more of them on the northern than on the southern side. The outflowing rivers in general work their way through the breaks between the mountains and flow southerly down the slopes to the Atlantic coast. The lake systems are at high elevations for lakes so near tide water, so that the outflowing rivers have large falls in their courses to the ocean. The following table gives the elevations of some of the larger lakes:

Elevations of the larger lakes and ponds of Maine.

Name.	Elevation above sea level.	Name.	Elevation above sea level.
	Feet.		*Feet.*
Moosehead Lake	1,023	Richardson Lake	1,456
Wood Lake	1,094	Mooselookmeguntic Lake	1,486
Attean Pond	1,094	Rangeley Lakes	1,511
Long Pond	1,094	Mattagamon Lake	859
Schoodic Lakes	500	Chamberlain Lake	926
Sebec Lake	375	Pomgocwahem and Churchill lakes	914
Baskahegan Lake	400	Alleguash Lake	950
Pamalumcook, The Twins, and Milinoket lakes	500	Eagle Lake	579
		Square and Cross lakes	587
Ripogenus Lake	878	Long Lake	603
Chesuncook Lake	900	Portage Lake	625
Caucuomogomoc Lake	930	Fish River Lake	660
Squawpan Lake	580	Chiputneticook Lake	382
Sebago Lake	247	Chiputneticook (Grand) Lake	449
Umbagog Lake	1,256		

Lake Itasca, at the extreme headwaters of Mississippi River, is at an altitude but little greater than that of the Rangeley Lakes. Lake Superior, at the source of the St. Lawrence, 1,800 miles by river from the ocean, is at an elevation about two-thirds that of Moosehead Lake.

Lake Winnepesaukee, in New Hampshire, is at an elevation hardly more than half that of the large lakes at the head of the Penobscot—Chesuncook, Chamberlain, etc. The great elevation of these lakes, the short courses of the rivers outflowing to the sea, and the fact that the lakes are largely located near the headwaters of the streams, make the rivers of the State far better for the development of water powers than the streams in almost any other part of the United States.

The climate of the State is highly favorable for a large and uniform run-off. The average temperature for the year is about 41° F., the average in summer being from 59° to 66°. The evaporation is comparatively small, owing to the low temperatures, the porous soil, the extensive forests, and the prevailing fogs. The rainfall is large and well distributed. Sudden heavy storms are rare, most of the water falling in comparatively gentle rains extending over considerable time. In winter nearly all of the precipitation is in the form of snow, which lies on the ground until late in the spring, gradually melting and adding to the volume of the rivers. The effect of the large rainfall and run-off and the small evaporation, of the topography, of the forest-covered areas, and, above all, of the large storage reservoirs in the form of natural lakes, is very apparent in the discharge of the streams.

A comparison of the records of flow of the rivers of Maine with those of other portions of the United States is most instructive. Many of the largest rivers of the Atlantic coast rise in the Blue Ridge and flow at nearly right angles to the ranges of the Appalachian mountain system. The tributaries drain valleys between these steep ranges, the valleys being narrow and the side slopes steep, so that rain falling upon the mountain sides soon reaches the river channels. In Maine, however, the mountain chains have lost their continuity and appear as groups or masses of low mountains or hills, with comparatively flat slopes and with broad, open river valleys. This topography tends to equalize the rainfall over the watersheds and to prevent the heavy rains from reaching the rivers immediately and causing high waters and disastrous floods. The effect of the heavy forest covering in the upper part of the drainage basins is also very beneficial, tending to equalize the yearly flow of the streams. The lakes, however, have a paramount effect upon the flow of the streams, acting as regulators, which make the rivers of Maine the finest in the United States for water-power developments. In the utilization of flowing water for power it is of the greatest importance that the flow be uniform throughout the year, and so equable is the flow of the streams of Maine that the users of water power in that State seldom realize the difficulties under which developments are made in other parts of the country where there are no lakes, ponds, or marshes upon which to draw during the period of low flow, necessitating the shutting down of the works during that season, or the construction of

auxiliary steam plants, which require fuel and for which interest and repairs must be provided throughout the year.

In those sections the dry season is followed by heavy rains, and, as has been explained, the rain water flows rapidly to the rivers, swelling them to flood heights and requiring strong and expensive constructions to resist its fury. The variation in the flow of the Maine streams, on the contrary, is naturally comparatively small, and when controlled by dams at the outlets of the lakes the uniformity of the discharge is almost unparalleled. An example of what is possible of attainment, under exceptionally favorable conditions, by artificial control in natural reservoirs for even a very considerable drainage area is well illustrated in the case of Sebago Lake, which covers nominally 50 square miles and drains 470 square miles. The average flow of this lake during the working days has in no month in ten years fallen below seven-eighths of a cubic foot per second per square mile; for three-fourths of the entire period it has not varied more than 20 per cent either way from an average of 1.75 cubic feet per second per square mile; and in an especially favorable year the entire range of flow has been not more than 5 per cent either way from the mean for the year. It will be seen that this regularity is most remarkable when compared with the Potomac, a river with a drainage area of 9,654 square miles at Point of Rocks, Md. (where is located a gaging station of the United States Geological Survey), and with a minimum flow of about 1,000 cubic feet per second, or 0.1 cubic foot per second per square mile. This contrast is the more striking when we consider the difference in size of the drainage areas, for the run-off from a large drainage basin is, other things being equal, greater per square mile than from a small one.

Though much has been done to control the storage water in the lakes in Maine, and thereby increase the dry-weather flow of the streams, more effective results could be obtained by systematic and cooperative control. Take, for example, the Penobscot, which at its lowest flow carries, at Oldtown, only one-third of a cubic foot per second per square mile of drainage area, owing to lack of proper regulation. The time will probably come when the manufacturers and log drivers will see the advisability of cooperative control, and when regulating works will be built at the headwaters and this river discharge at its minimum flow several times that quantity of water. Presumpscot and Cobbosseecontee rivers are wonderful examples of the benefits derived from the excellent natural facilities for storage which have been artifically improved.

Although uniform in their flow in comparison with rivers in other parts of the country, the large rivers of the State are subject to great variation when compared with the Presumpscot and the Cobbosseecontee, much greater than would be the case were more extensive controlling works built at the outlets of the various lakes and ponds.

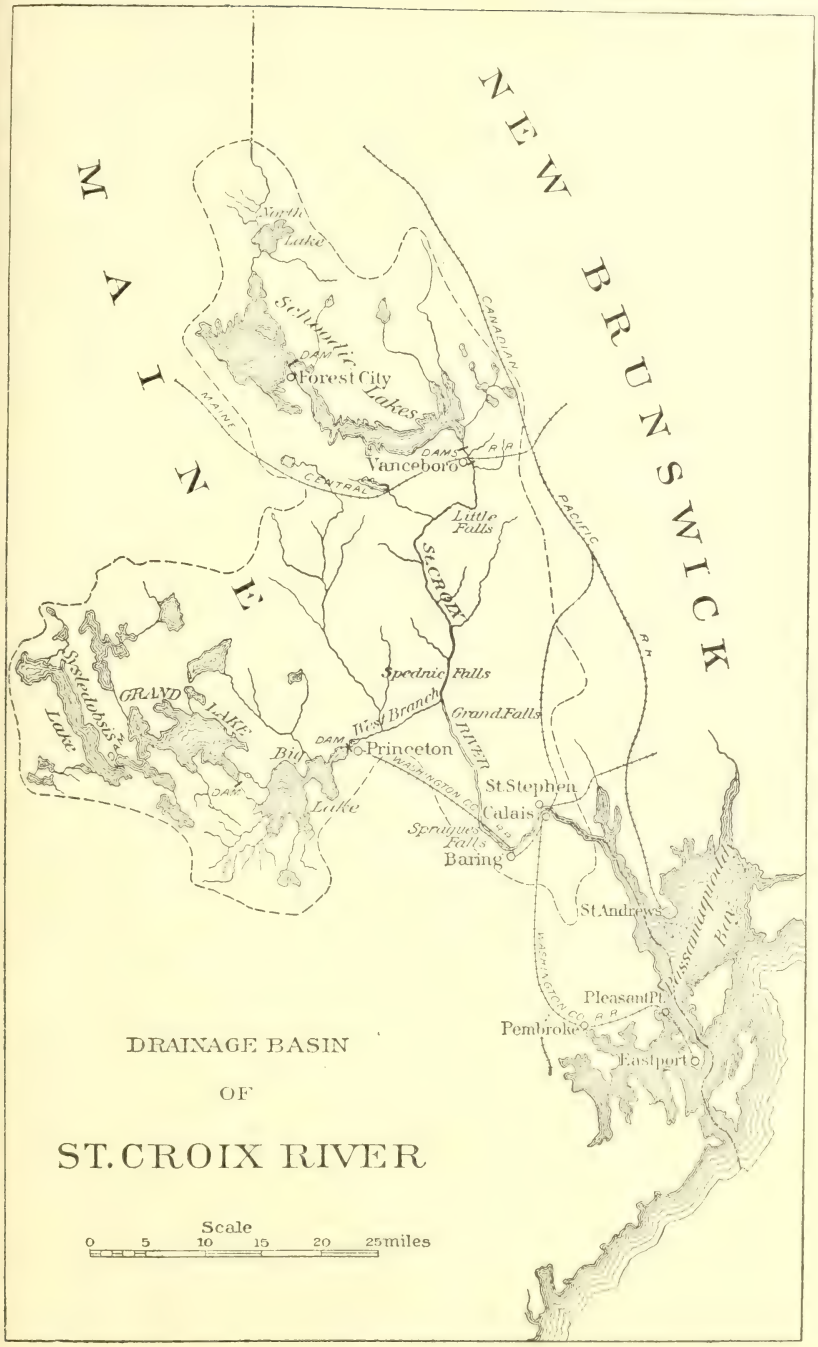
Unfortunately our information in regard to the flow of the rivers of Maine is not as extensive or accurate as might be desired, the information we have being derived from measurements made by corporations and engineers, either for their own use or for general information upon a subject which must always be of the greatest interest to the people of the State. During the summer of 1901, however, the United States Geological Survey established rain gages and gaging stations on several of the rivers, with the idea of extending hydrographic investigations over a series of years, in order to obtain more information as to the possibilities of increasing the power at plants already established, and determine the power available at sites not yet developed. The results of these investigations will be published from time to time, but in order that the data now available may be in form for easy reference, the records of flow are assembled in this paper.

ST. CROIX RIVER.

DRAINAGE BASIN.

St. Croix River is formed by two branches, known as the Upper St. Croix or Chiputneticook River, the outlet of the Schoodic Lakes, and Kennebasis River, the outlet of the western lakes of the area, known as the Kennebasis Lakes. (See Pl. III.) The Upper St. Croix, with its tributary lakes, forms nearly half of the eastern boundary of Maine, separating that State from New Brunswick. The total drainage area of the main stream is about 1,630 square miles, of which 960 square miles are tributary to the great reservoir systems controlled by dams at Vanceboro and Princeton. The length of the stream from the headwaters to the mouth is 100 miles. The basin is, in general, lower than that of any of the larger streams of the State flowing into the Atlantic, its headwaters having an elevation of about 540 feet. The fall from Chiputneticook Lake (the lower of the Schoodic Lakes) to tide water, a distance 54 miles, is, however, 382 feet, or 7 feet to the mile, and there are a number of places where falls and rapids occur at which water power has been or can easily be developed.

The lake system of the St. Croix is the largest in the State in proportion to the drainage basin, except that of the Presumpscot, and as the lakes act as a regulator of flow and can easily be improved for greater duty, St. Croix River may be considered one of the best water-power streams on the Atlantic coast. The lake system of the Upper St. Croix comprises approximately 50 square miles of lake surface, and that of the West Branch 70 square miles, considering only the principal lakes and ponds. Indeed, above Vanceboro and Princeton each branch of the river is simply a succession of lakes to almost the extreme headwaters. Wells estimated the total lake surface of the St. Croix as not less than 150 square miles, or nearly one-tenth of


MAINE
NEW BRUNSWICK
North Lake
Schoodic Lakes
DAM
Forest City
MAINE CENTRAL
CANADIAN PACIFIC R.R.
DAMS
Vanceboro
Little Falls
St. CROIX
Spednic Falls
West Branch
Grand Falls
RIVER
Princeton
Big Lake
GRAND LAKE
Scheoboosis Lake
WASHINGTON CO.
Sprague's Falls
Baring
St. Stephen
Calais
St. Andrews
Passamaquoddy Bay
Pleasant Pt.
Pembroke
Eastport
DRAINAGE BASIN
OF
ST. CROIX RIVER
Scale
0 5 10 15 20 25 miles

the total drainage area. The drainage area at various points on the river is given in the following table:

Drainage area of St. Croix River.

	Sq. miles.
Main river:	
Vanceboro dam, foot of the Schoodic Lakes	420
Little Falls	500
Immediately above mouth of West Branch	650
Immediately below mouth of West Branch	1,400
Spragues Falls	1,450
Calais, lower dam	1,530
Mouth of river, eastern border of town of Calais	1,630
West Branch:	
Princeton dam	540
Confluence with main river	750

A large proportion of the drainage basin is still covered with timber, and above Vanceboro and Princeton the region is for the most part wild and inaccessible, being visited only by lumbermen and sportsmen. The greater part of the timber in this region is controlled by sawmill owners at Calais and St. Stephen. In 1898 the amount of lumber sawed annually had fallen from about 100,000,000 feet to 25,000,000 feet, and since then the number of sawmills has been greatly reduced. In 1901 the lumber sawed amounted to 28,000,000 feet, showing that the rate of cutting has remained nearly constant during the last few years. There are on this stream favorable locations for paper and pulp mills, but arrangements would have to be made with the sawmill owners in order to obtain a supply of timber.

The river is navigable as far as Calais, except during two months of the year, when it is frozen. Calais has railroad connection with Bangor directly over the Washington County Railroad, and, by way of Vanceboro, over the Canadian Pacific and the Maine Central railroads. There is also a short road connecting Princeton with Calais. Above Princeton the transportation facilities are poor. Calais, Princeton, and Vanceboro, in Maine, and St. Stephen, in New Brunswick, are towns with populations of from 1,000 to 10,000, largely engaged in the manufacture of lumber.

LAKE STORAGE.

The storage in the principal reservoirs of the St. Croix is controlled by the St. Croix Log Driving Company, a chartered association comprising the various mill owners upon the river. This company has a monopoly of log driving on the stream, inasmuch as no one can drive logs unless he comply with its conditions and share its expenses. It maintains dams at certain lakes, in order to drive logs down to Baring, and assesses equitably upon the members the cost thereof. The object of the company is primarily to facilitate

log driving, and for that purpose water is drawn from the lakes in whatever amount needed for a period of perhaps fifty or sixty days, but for the remainder of the season the company seeks to utilize the lake storage as far as possible for the water-power interests of the river.

In the basin of the West Branch the company maintains dams controlling the storage in Big Lake, Grand Lake, and Sysledobsis Lake. The dam at the foot of Big Lake and its prolongation through Long and Leweys lakes is at Princeton, and gives about 5 feet of available storage, the three lakes being credited by Wells with about 16 square miles of surface. At a very small expense this could be largely increased. The tributary drainage area is large, amounting to 540 square miles, and every spring there is wastage at the dam. Grand Lake, the next lake above on this branch, and between 80 and 90 feet higher than Big Lake, is controlled by a dam giving 6 or 7 feet of storage, extending back over Grand, Compass, Junior, and other smaller connecting lakes. The area of water surface commanded can not be given with accuracy, but from Wells's figures it would appear to be more than 25 square miles. Still farther above, at the outlet of Sysledobsis Lake, is a dam giving a storage of approximately 8 feet in that lake, which is stated by Wells to have a surface of 7 square miles.

On the East Branch, or the main St. Croix River, the dam at Vanceboro commands 13½ feet of storage over about 27 square miles in the lower of the Schoodic Lakes (Chiputneticook Lake); while above, at Forest City, another dam gives a few feet of storage over the 25 square miles of the upper of the Schoodic Lakes (North Lake).

There are also private dams on most of the minor streams, but the storage in each case is small in comparison with that obtained at the foregoing lakes. The private dams are not kept in repair, and the reservoirs receive no attention after being drawn down for the season. Much might be accomplished to improve the storage of the river as a whole by bringing these numerous private reservoirs under a general system of control, if that were found practicable. It is doubtless also possible greatly to increase the storage in many existing reservoirs by increasing the heights of the dams. The country surrounding the lakes is flat, and even low dams produce extensive flowage. While improvements of this nature could have easily been made many years ago, when the flowed tracts were woodland, they are not now so feasible in the case of the larger lakes because of the altered uses of the land and the consequent increased damages which would be incurred.

No measurements of the flow of the river have ever been made, so far as can be ascertained, and the experience of the mills now in operation along it throws the only light obtainable on that subject. The level, wooded surface of the basin and the large extent of lake and

swamp area naturally result in a well-sustained low-season flow, despite the subordination of water power to log driving in the management of the storage. On the other hand, the freshet rise is not excessive, the extreme range between high and low water amounting to 6 feet on the Baring dam and probably not exceeding 8 feet anywhere on the river.

WATER POWERS.

A monument marking a point upon the State boundary at the extreme headwaters of the main St. Croix is 538 feet above tide, from which there is a descent of nearly 100 feet to Grand Lake. From Grand Lake to the lower of the Schoodic lakes, or Chiputneticook Lake, as it has also been called, there is a fall of about 60 feet. At the Vanceboro dam, at the foot of Chiputneticook Lake, no power is used, but a half mile or so farther downstream there is a dam at which a fall of about 8 feet was formerly employed for nine turbines operating the machinery of the International Leather Company's tannery. The tannery was burned, and the site is now unutilized. From this point no dam is encountered on the St. Croix before reaching Baring, nearly 50 miles below, excepting an occasional wing dam, built by the log drivers for the purpose of controlling the channel. Despite the relatively low elevation of the St. Croix Basin the river has a good slope, averaging about 7 feet to the mile and amounting to more than 350 feet from below the lower Vanceboro dam to mean tide at Calais. Of this amount approximately two-fifths in the aggregate, or, say, 140 feet, is concentrated at Spednic Falls, Grand Falls, Spragues Falls, and Calais, the remainder being spread over the various rips and the smooth-flowing sections of the stream. At the falls the banks are generally high and rocky, but elsewhere they are commonly low and succeeded by wide, level stretches of wooded land. Here and there, noticeably above the Canoose Rips, the river widens to almost the dimensions of a lake, being for miles a stream 1,000 feet or more in width, with gentle current. The distribution of the entire fall of the river, as determined by Anson's survey, made prior to 1840, and quoted by Wells in The Water Power of Maine, page 115, is set forth in the following table. The figures given, however, are perhaps subject to minor changes for the upper and lower extremities of the stretch considered, due to the construction of dams since the survey was made.

Fall in St. Croix River.

Locality.	Distance from Calais bridge.	Height above approximate low tide.[a]	Fall between points.	Distance between points.	Average fall per mile between points.
	Miles.	*Feet.*	*Feet.*	*Miles.*	*Feet.*
Grand Lake, at foot	54.62	382.6			
			9.7	0.56	
Foot of Kill-me-Quick Rips	54.06	372.9			
			14.6	3.04	
Head of Mile Rips	51.02	358.3			
			22.9	1.00	
Foot of Mile Rips	50.02	335.4			
			83.2	10.07	
Head of Rocky Rips	39.95	252.2			
			24.8	3.38	
Foot of Rocky Rips	36.57	227.4			
			1.0	0.63	
Head of Meetinghouse Rips	35.94	226.4			
			7.7	1.06	
Foot of Meetinghouse Rips	34.88	218.7			
			0.2	1.00	
Head of Haycock Rips	33.88	218.5			
			6.0	0.39	
Foot of Haycock Rips	33.49	212.5			
			0.6	2.88	
Head of Canoose Rips	30.61	211.9			
			11.2	0.56	7.00
Foot of Canoose Rips	30.05	200.7			
			10.7	7.30	
Head of Spednic Falls	22.75	190.0			
			20.1	0.53	
Foot of Spednic Falls	22.22	169.9			
			3.9	2.25	
Grand Falls, head of upper pitch	19.97	166.0			
			20.0	0.56	
Grand Falls, lower pitch	19.41	146.0			
			17.8	7.93	
Head of Enochs Rips	11.48	128.2			
			9.6	0.69	
Head of Spragues Falls	10.79	118.6			
			25.4	0.36	
Foot of Spragues Falls	10.43	93.2			
			6.7	5.05	
Baring bridge	5.38	86.5			
			13.9	3.60	
Milltown, upper bridge	1.78	72.6			
			72.6	1.78	
Calais bridge	0.00				

[a] Mean rise and fall of tide about 20 feet.

After passing the village of Vanceboro the first important pitch encountered is that at Little Falls, about 8 miles downstream, although rapids occur at intervals in the intervening stretch, the most noticeable of them being the Mile Rips. At Little Falls the river descends over ledges perhaps 3 or 4 feet in as many hundred feet. The banks are high and rocky, and the site appears excellent for a dam of moderate height, which probably need not be more than 200 feet long, and which would give a fine pondage over the wide and sluggish stretch of river above. For the first 6 or 8 miles below Little Falls there is a succession of rips of varying degrees of roughness. The river then becomes wide and sluggish, measuring probably 800 or 1,000 feet between banks, and in the 4 miles from Keene Place to Canoose Camp is broken only by the rips near Rideouts. At the Canoose Rips, about 12 miles below Little Falls, the descent is considerable, amounting, according to the table above, to 11 feet in about a half mile. Less than a half mile below the Canoose Rips are the Dog Island

Rips, short but heavy, and for the succeeding 8 miles to the Spednic Falls the river is almost uniformly smooth.

The Spednic Falls are not more than 2 miles above the mouth of the West Branch of the St. Croix, and form an important water privilege. The river here descends in a succession of pitches and rapids, mainly within a distance of 1,000 feet, and with a total fall of about 20 feet in a half mile. At the head of the falls the banks are rocky, though not high, and the main channel is narrow. One or more side channels through which the stream naturally flowed have already been dammed by the lumbermen.

Almost immediately below the mouth of the West Branch are the Grand Falls, comprising what are known as the upper and lower pitches, perhaps a half mile apart, and each covering a fall of 15 or 20 feet. At the upper pitch there is an abrupt fall of about 6 feet, followed by heavy rapids. The river is divided by a rocky island, but by means of a log wing dam its flow has been confined within a single main channel. The lower falls are a close counterpart of the upper falls in all the principal features, and both are regarded as important sites for power.

Below the Grand Falls there are only occasional small rips for 8 miles. Then are encountered the Enochs Rips, closely succeeded by the Spragues Falls, the latter undoubtedly constituting the principal undeveloped water power of the river. A view of the upper pitch of these falls is shown in Pl. IV, *A*. The Washington County Railroad, running from Calais to Princeton, skirts the east bank of the river opposite the falls and crosses a short distance upstream. There is a resemblance to the sites at the Grand and the Spednic falls, in that the river is divided by a rocky island. The channel to the right of this island has been closed, for log-driving purposes, by a long and high wing dam, forcing the river between the island and the left or east bank. This channel is 150 or 200 feet wide, and at the head of the falls the facilities seem excellent for the construction of a dam, which would have for abutments the ledges of the island and the left or main bank, both of which are of sufficient height. Approaching the falls from above, there are heavy rapids for 500 feet, then an abrupt pitch of 6 or 8 feet, followed by rapids and minor pitches for 800 or 1,000 feet farther, the total descent, according to Anson's old survey, amounting to 25 feet in a third of a mile, or if combined with the Enochs Rips to 35 feet in a mile. All things considered, the water power at Spragues Falls is an excellent one. No very close estimate, however, can be made as to the amount of power available. The drainage area is not materially different from that at Calais, and, judging from the experience of the mills in that city, the power probably would not, in an extreme drought like that of 1895, exceed 40 or 50 net horsepower per foot of fall, continuous for the twenty-four hours, or, say, from 1,000 to 1,200 net horsepower for the entire fall

of 25 feet. The shortage of 1895 is attributed in part to unwise management of the lake storage, and it seems certain that throughout ordinary years the power at Spragues Falls is much in excess of the figures given.

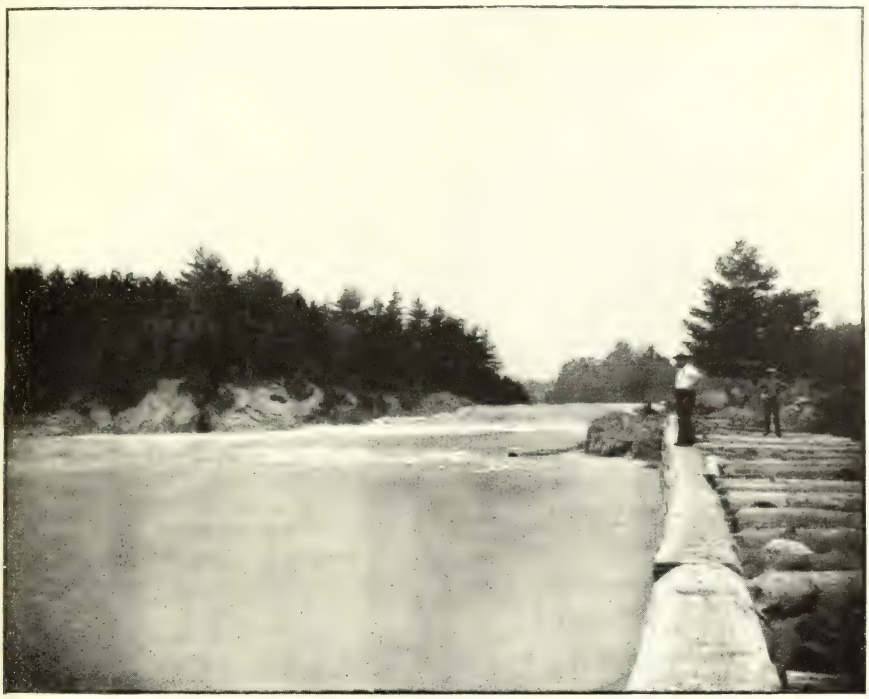
In the 5 miles between Spragues Falls and Baring the river has but slight fall, and on that account affords large pondage and valuable storage space for logs. At Baring there is an old, dilapidated, and leaky dam, built from ledge to ledge, affording a head of 8 or 10 feet at the mills, although from the ordinary level of the mill pond to the foot of the rips below the dam the fall is stated to be about 12 feet. Thirty years ago a large amount of lumber was sawed here and 8 or 10 gang saws were in operation; but the old mills have been burned and not rebuilt, and the manufacturing is now confined to two small establishments on the American side of the river making shingles, barrel heads, and box shooks.

The next and last power is that at Calais and vicinity. The St. Croix, which above this point in general runs between low banks and is depressed but little below the level of the adjacent country, here appears to have worn its channel much below that level, and in less than 2 miles from the surface of the upper pond at Milltown to tide water at the lower Calais bridge descends about 54 feet, measured to ordinary high tide, or about 20 feet more than that if measured to ordinary low tide. Calais and its upper suburb of Milltown lie on the American bank, and St. Stephen and its suburb, also called Milltown, lie across the river. Manufacturing is conducted at four log dams, three of which appear to be old and leaky.

At the upper dam the fall is 12 feet, and the power is owned by H. F. Eaton & Sons, who operate a sawmill on each bank, the one on the Canadian side being equipped with one gang saw and a planing mill, and the one on the American side with two gang saws, a planing mill, and a box machine. These mills have a combined capacity for sawing more than 25,000,000 feet of lumber in a season.

A short distance below the Eaton mills a wing dam on the American side (commanding a part only of the flow of the river) gives a fall of 9 feet, the power being used in James Murchie & Sons' mill, which is equipped with three gang saws, a planing mill, and a shingle mill. On the opposite side of the river is a dam in a dilapidated condition, giving a fall of a few feet, now used only for a gristmill.

The next privilege occurs at what is known as the Salmon Falls, and is the most important and best developed in this locality. It is owned by the Canadian Cotton Mills Company, Limited, which has on the New Brunswick bank a fine mill equipped with 34,000 spindles and 1,100 looms, employing 725 operatives. (See Pl. IV, *B*.) The dam is a tight and costly structure of log cribs packed with stone, the half near the mill being packed with concrete. It develops a normal fall of about 21 feet. Three 54-inch Hercules turbines are installed, but only from 1,000 to 1,100 horsepower is actually employed. For this



A. UPPER PITCH OF THE SPRAGUES FALLS, ST. CROIX RIVER.

B. SALMON FALLS AND MILL OF CANADIAN COTTON MILLS COMPANY, ST. STEPHEN, NEW BRUNSWICK

there has been no shortage except in the summer or fall of 1895. The mill is dependent upon the continuous flow of the stream, the pond being small and no material aid being received from the storage of night flow either here or at the dams above.

The last dam on the river is near the head of tide water. It gives a fall reckoned at 10 feet normal, but varying with the season from 8 feet at times in dry weather to 12 or 13 feet in freshets. The ordinary tidal rise and fall below the dam is 1 or 2 feet, and that in spring tides 3 or 4 feet. The entire privilege is owned by Mr. Frank Todd, who operates mills on both banks, ordinarily sawing in the aggregate 8,000,000 or 10,000,000 feet of lumber per annum. He also owns the electric-light station, at which 500 horsepower of turbines are installed, about 200 horsepower of which are at present in use. He proposes also to build on the American bank a sulphite pulp mill. Below this dam heavy rapids are exposed at low tide, but, being near the head of tide water, the power is of little consequence.

WEST BRANCH OF ST. CROIX RIVER.

The West Branch has a much larger drainage area than the East Branch, or what has been called the main St. Croix River, comprising 750 square miles at the confluence of the two streams and 540 square miles at Princeton. No power is used, however, except at the Princeton dam, at the foot of Big Lake, or, perhaps more properly, at the foot of the eastern extension known as Leweys Lake. This dam is an old structure, clearly allowing much leakage, and gives a head at the mills, at a favorable stage of the water, of about 9 feet. Power is used for F. Mercer & Sons' gristmill, box mill, and sawmill, the latter manufacturing from 7,000,000 to 8,000,000 feet during the season, and for S. L. Peabody's one-set woolen mill.

From Princeton to the mouth of the West Branch, a distance of about 8½ miles, the fall amounts to between 12 and 13 feet, according to Anson's survey. Much of the way the stream flows between low banks, from 250 to 350 feet wide in the narrower portions of its course, but in places spreading out to a much greater width. The current is gentle and the surface smooth, broken only by the Tomah and the Black Cat rips, both of which can readily be ascended by poling in a canoe. Above Big Lake the outlet stream from Grand Lake has a fall, by Anson's survey, of 82 feet in its length of 2¾ miles, doubtless furnishing good water powers, but at present removed from settlement and from railroad communication.

PENOBSCOT RIVER.

DRAINAGE BASIN.

The Penobscot has the largest drainage basin of all the rivers in Maine, comprising about 8,500 square miles, or more than one-quarter of the entire State. (See Pl. V.) Its greatest length from north to south is 160 miles, its greatest width 115 miles, all within the State.

Eight hundred square miles of the basin discharge their waters into the main river below its lowest water power at Bangor.

The basin is at a lower elevation above the sea than the basins of the Kennebec and the Androscoggin, as would be expected from the general southeasterly slope of the country toward the Atlantic Ocean. The northern portion, however, is rather elevated, having a mean height of about 1,000 feet. The highest portion of the basin is at the headwaters of the main river, where the elevation is from 1,600 to 2,000 feet.

Taken as a whole, the basin is rather uniform in its topographic features. Hills and low mountains stretch from near the sea above Bangor; farther north is an undulating plain, while to the west the surface becomes more broken and greatly diversified by hills, detached peaks, lakes, ponds, and swamps. At the south the basin merges into that of the Kennebec, and at the north into that of the Alleguash, terminating on the northwest, at the boundaries of the State, in a highland region intermingled with swamps and lagoons, the latter furnishing water to the Penobscot and the St. John. A large part of the basin is what is known as "wild land," being heavily timbered and known only to the lumberman and the sportsman. Few regions in the country are more delightful to the lover of nature than the forests, the lakes, and the mountains on the headwaters of the Penobscot. From Mount Katahdin, the highest mountain of the State, a view can be obtained in all directions, overlooking the extensive plain and showing vast stretches of forests dotted here and there with lakes.

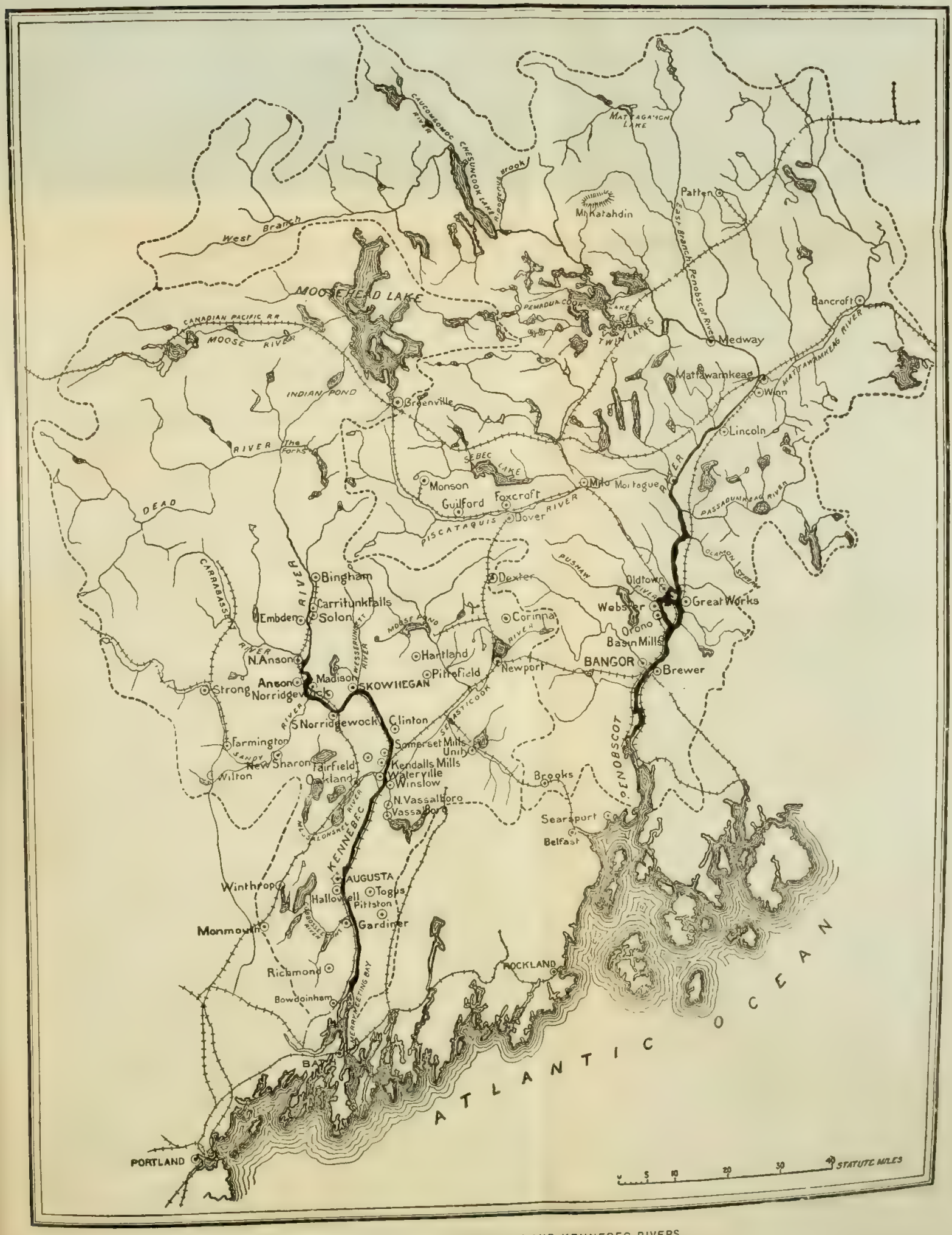
Over the upper portion of the basin slate is the principal surface rock, being succeeded to the east and south by schists, gneiss, and granite; the soil is mainly gravel, clay, and loam.

The drainage areas of the river and its chief tributaries are given in the following table:

Drainage areas of Penobscot River and principal tributaries.[a]

River.	Locality.	Drainage area.
		Sq. miles.
Penobscot	Opposite northwest extremity of Moosehead Lake, township of Seboomook, immediately below mouth of Nulhedus Creek.	600
Do	Entrance into Chesuncook Lake	870
Do	Outlet of Chesuncook Lake	1,440
Do	Outlet of Twin Lakes	1,990
Do	Immediately below mouth of East Branch of Penobscot	3,160
Do	Immediately below mouth of Mattawamkeag River	4,810
Do	Immediately below mouth of Piscataquis River	6,590
Do	Oldtown, above mouth of Pushaw River	7,240
Do	Bangor	7,910
Do	Mouth	8,550
Fauquomogomoc	Entrance into Chesuncook Lake	230
East Branch of Penobscot	Mouth	1,170
Mattawamkeag	Immediately below outlet of Baskabegan Lake	190
Do	Mouth	1,530
Piscataquis	Dover	380
Do	Immediately below outlet of Sebec Lake	750
Do	Mouth	1,500
Passadumkeag	do	400

[a] Measured on G. W. & C. B. Colton & Company's map of Maine, published in 1883.



DRAINAGE BASINS OF PENOBSCOT AND KENNEBEC RIVERS.

2:

E
th

th
g
T
h
h
2,

fe
B
su
de
m
Al
St
th
la
tin
Fe
th
th
St
siv
wi
(
ro
gr
2
the

Pen

I
I
I
I
I
I
I
I
I
Cam
East
Matt
I
Pisc
I
I
Pass

The river naturally has a comparatively uniform flow throughout the year, which is due to the extent of the tributary area, its extensive system of lakes, the vast breadth of forests upon its drainage surfaces, and the more uniform surface of the basin, in which particular it has decided advantage over the Saco, the Androscoggin, and the Kennebec.

The United States Geological Survey now maintains a gaging station on the river at Montague.

LAKE STORAGE.

In common with the other large rivers of the State, the Penobscot has a great many lakes and ponds which serve to regulate naturally the flow of the river, and which could be utilized to far greater extent to increase the low-water flow for manufacturing purposes. There are in all 467 lakes in the Penobscot Basin. The aggregate area of these is estimated to be 585 square miles, or 1 square mile of lake surface to each 14 square miles of land surface. The following table gives the areas of the principal lakes and ponds. The lakes range in size from about 22 square miles (Chesuncook) downward, nine of them covering an area of 10 square miles or more each, and the average of all being about 1.2 square miles.

No single lake or series of lakes of the Penobscot system can compare with the Umbagog series of the Androscoggin, or with the Moosehead of the Kennebec, nor, when drainage basins are compared, with the Schoodic Lakes of the St. Croix, the Eagle Lakes of the Fish, or Sebago Lake of the Presumpscot, as a reservoir to tide over dry-weather flow. Considering size of basin and main drainage stream, the leading lakes are relatively smaller and are scattered, so that they can not be commanded by a few artificial constructions. The river can not be fully developed and the greatest amount of power realized until power plants have been constructed on the main stream and on the many tributaries, so that each small dam will do its part in holding back the flood flows and permitting the water to slowly flow toward the ocean, and thus augment the dry-weather flow. The possibilities of largely increasing the storage in the lakes at the headwaters are particularly favorable, requiring only the construction of low dams. The areas overflowed on the shores of the lakes and in the swamps (of the latter of which there are many) would be of but little value.

Surface areas of principal lakes and ponds in the Penobscot Basin.

Draining to—	Sq. miles.
Piscataquis River	85.90
Passadumkeag River	31.25
Mattawamkeag River	53.35
East Branch of Penobscot	42.30
Penobscot River above outlet of Chesuncook Lake	80.65
Penobscot River between Chesuncook Lake and outlet of Twin Lakes	64.25
Penobscot River between outlet of Twin Lakes and Bangor	54.50
Total	412.20

CONTROL OF STORAGE AT TWIN DAM.

The uppermost point at which the Penobscot is at present directly touched by a railroad is Twin dam, at the outlet of North Twin Lake. Here is controlled, for log-driving purposes, the splendid storage afforded by North Twin, South Twin, Pemadumcook, Ambajejus, and other connecting lakes. The dam by which this is effected is a timber structure about 400 feet long, with perhaps 100 feet of embankment at each end. It consists of a series of log and stone crib-work piers alternating with gates and sluiceways, and is a very old structure, in a somewhat dilapidated but perhaps serviceable condition. The distance from the top of the cross timbers to the bottom of the gates is about 17 feet, which substantially measures the depth of storage afforded by the dam. The lake fills regularly in the spring, and by May or June water is overflowing the dam.

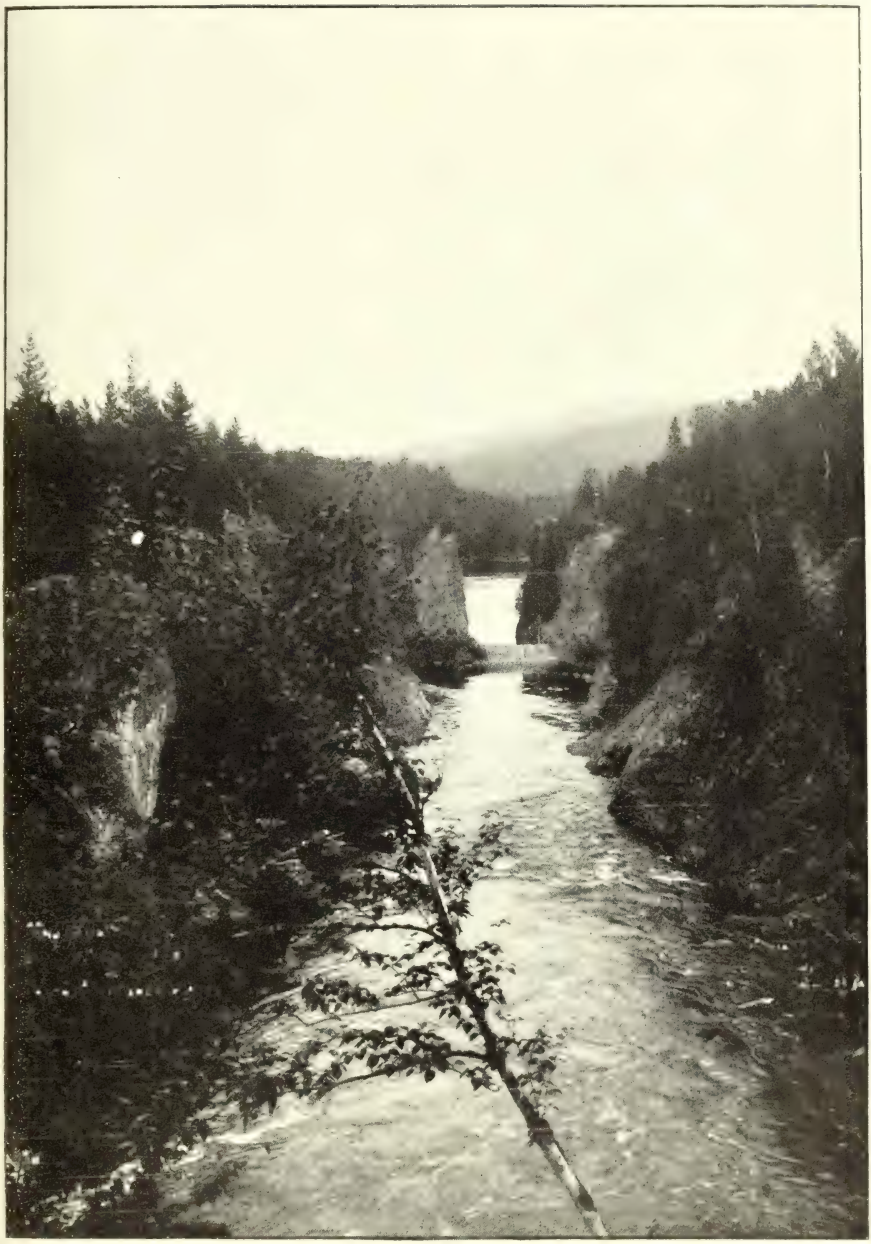
The logs driven down from the Upper Penobscot and other tributary streams are finally collected in the lake and towed in rafts to the vicinity of the North Twin dam, where those destined for the Great Northern Paper Company are separated from the rest of the drive and held for use at Milinoket. This dam was built by the Penobscot Log Driving Company. The water stored in the Twin Lakes is used for log-driving purposes so far as necessary. The same company maintains dams farther up the Penobscot, at the foot of Ripogenus and Chesuncook lakes, as well as at the outlet of Milinoket Lake, which drains into the Penobscot about 6 miles below the North Twin dam.

At the outlets of most of the other and smaller lakes there are also dams maintained for log-driving purposes by individual owners. About 5 miles below the North Twin dam is the concrete dam built by the Great Northern Paper Company in the development of their power at Milinoket. This dam is about 20 feet high and backs the water nearly to the North Twin dam, raising the surface of Quaquish Lake several feet.

WATER POWERS.

As has been stated, the elevation of the basin of the Penobscot is not as high as that of the basins lying farther to the west. At the remote sources of the river, 200 miles by water from the outlet into Penobscot Bay, the divide averages perhaps 1,800 feet above sea level. In the 50 miles from the head of the southwestern branch to Chesuncook Lake there is a descent of about 600 feet, but the stream is small and practically inaccessible.

Below Chesuncook Lake the river falls about 400 feet in less than 20 miles before entering Pemadumcook and Twin lakes, but it is in a wilderness having no direct railroad communication. Part of this distance it flows through a narrow channel with steep and rocky sides,



GREAT ARCHES AT RIPOGENUS, BELOW CHESUNCOOK LAKE, PENOBSCOT RIVER.

the current of the river being swift, with frequent falls over rocky ledges. (See Pl. VI.)

In the 30 miles between the Twin Lakes and the mouth of Mattawamkeag River the Penobscot descends 288 feet. A portion of this fall is utilized at Milinoket, where has been constructed the largest pulp and paper plant in the world. The total flow of the river at that point is diverted through a canal about a mile long, used in one head of 110 feet, and turned into Milinoket River as a tailrace.

In the 60 miles from the mouth of the Mattawamkeag to Bangor there is a fall of 177 feet. About half of this fall occurs in the 14 miles from the head of the Cookis Rips, above Oldtown, to tide water at Bangor, and in this distance several power developments have been made, dams being built across the main channel at five places, utilizing an aggregate fall of between 55 and 60 feet. There are also three dams on what is known as Stillwater Branch, at Stillwater, and at Orono. Farther upstream, at Montague, a 20-foot fall in the main stream is utilized.

The following table gives the elevations at various points on the river:

Fall in Penobscot River.

Locality.	Distance from mouth of river.[a]	Height above mean tide.	Fall between points.	Distance between points.	Average fall per mile between points.	Authority.
	Miles.	*Feet.*	*Feet.*	*Miles.*	*Feet.*	
Penobscot Lake, head of Southwest Branch.	218	1,509				
			475	25	19.0	
Off northwest angle of Moosehead Lake.	193	1,034				
			134	24	5.6	Wells: The Water Power of Maine, p. 101.
Head of Chesuncook Lake	169	900				
Foot of Chesuncook Lake	151	900				
			400	18	22.2	
Head of Pemadumcook Lake.	133	500				
Foot of the Twin Lakes	116	500				
Bangor and Aroostook Railroad crossing, below foot of the Twin Lakes.	116	465				Moses Burpee, chief engineer Bangor and Aroostook Railroad.
			288	29	9.9	

[a] Measured on Colton's map of Maine.

The Milinoket mills utilize a head of 110 feet, and at full gate have a capacity of 20,000 horsepower. Gagings of the canal show that when running at its full capacity the canal carries 19,000 cubic feet per second. There is, however, surplus power at this plant, so that at no time are all the gates open to their full capacity. With the Milinoket Company and the three other large pulp mills operated by water power, the pulp industry may be considered the most important on the river.

Above Oldtown the river contains numerous islands, dividing the stream into channels, which have proved favorable for the handling

of logs to be sawed at the various mills below. There are seven of these mills operated by water power on the Penobscot and the Stillwater Branch, and with their planing, shingle, lath, clapboard machines, etc., they are the second largest users of power on the river. The sawing season, however, lasts only about six months—from May to November—the river being frozen over the remainder of the time, thus precluding the handling of logs in the customary manner.

About 3 miles above Bangor, at Veazie, is the electric power and light station for the city of Bangor, operated by about 1,500 horsepower of turbines. One hundred and twenty horsepower or thereabouts is used by an electric-lighting station at Oldtown, and 250 horsepower for the municipal lighting plant at the Bangor pumping station. Water power is also utilized for pumping public water supplies from the river at Oldtown, Veazie, and Bangor. These works, with those already enumerated, and with a single woolen mill at Oldtown and a cant-dog shop at Orono, comprise all the users of water power from the Penobscot.

The power development at Milinoket utilizes the total fall between the North Twin dam and the outlet of Milinoket River. Between the latter place and Medway there is a large fall that is still undeveloped. At Medway the flow is largely increased by the addition of the waters of the East Branch, and at Mattawamkeag by those of Mattawamkeag River. From Medway to Mattawamkeag the water is relatively smooth, although with a swift current.

A short distance below the mouth of Mattawamkeag River the Penobscot, there about 500 feet wide, is crossed by the Canadian Pacific Railway; but there is neither bridge nor dam elsewhere upon its course below Milinoket until the immediate vicinity of the mouth of the Piscataquis is reached. In the stretch from the Mattawamkeag to the Piscataquis the river has a good current, with rapids at what are known as the Five-Islands Rips, opposite the village of Winn, and at the upper and lower Mohawk Rips, opposite South Lincoln. At Winn the rapids are heavy, the river bed is composed of rock, which here and there rises above the water surface, the banks are high, and the site appears to be an important one for the development of power. At the lower Mohawk Rips the river is probably 800 or 1,000 feet wide, the bed partly of rock and strewn with bowlders, the banks gravelly and of fair height, but the site appears of much less consequence than that at Winn.

Between the towns of Enfield and Howland, and a quarter of a mile or more above the mouth of the Piscataquis, is the power plant of the Piscataquis Falls Pulp and Paper Company, whose mill has a capacity for manufacturing daily 40 tons of mechanical wood pulp. This privilege was developed six or eight years ago, and practically the same men who compose the Piscataquis Falls Pulp and Paper Company have a mill at Great Works, below Oldtown. The dam, like almost

all of the dams on the rivers of Maine, is a log crib-work structure packed with stone. Its length is about 1,000 feet, and, as is necessary upon a river so largely utilized for log driving, a sluiceway for logs is provided in the central part of the structure. The hydraulic canal follows the east bank for about 1,000 feet, or to the mill, taking the course of an old navigation canal by which steamboats formerly passed the falls. At the mill a head of 20 feet is obtained for the turbines, of which 2,500 horsepower are installed. There is no lack of water, except occasionally a slight shortage in the latter part of August or the early part of September.

Below the Piscataquis there are no dams until Oldtown is reached, but there are occasional rapids offering possible sites for the development of power. Where confined within a single channel the river appears generally to be nearly or quite 1,000 feet in width, but islands frequently divide it into several channels. The Passadumkeag Rips are close to the mouth of Passadumkeag River. Here the banks are of good height, and there is considerable exposed rock in the east bank and on the river bed, but it is questionable whether a dam of suitable height could be built without causing backwater upon the privileges on the main river and on the Piscataquis at Howland. A more promising site is that at the Birch Island Rips, perhaps 2 or 3 miles below the mouth of Olamon Stream. These rips are short, but strong, and the river is divided by a rocky island.

Above and in the vicinity of Oldtown, as already mentioned, the Penobscot is divided by many islands, differing greatly in size; the channels between them are variously controlled and utilized in the operations of sorting, storing, and driving logs. Opposite Oldtown the waters become confined to substantially two channels—the main Penobscot River and the Stillwater Branch—between which the flow in low stages appears, from measurements made ten or twelve years ago by Prof. George H. Hamlin, to be divided in the ratio of from five to eight parts in the former to one part in the latter, and on which the water-power improvements at Oldtown and Orono are situated.

On the main river the upper privilege at Oldtown is owned by the Bodwell Water Power Company, which leases power to the present users. The dam is a log crib-work structure from the left bank to an exposed ledge in the center of the stream, and from that point to the right bank it is built of squared timbers, the spaces being filled with stone. The influence of this dam extends a mile or more upstream, and is terminated by short but heavy rips in the channels into which the river is divided. On the left bank the fall available at the mills is stated to be 15 feet, and power is used by the sawmills of B. B. Thatcher & Company and the Jordan Lumber Company, which together manufacture from 20,000,000 to 25,000,000 feet of lumber during the season, and by the Oldtown Electric Light Company,

which uses more than 100 horsepower. On the right bank water is admitted through a substantially constructed bulkhead to a canal 40 or 50 feet wide, inclosed by a heavy wall on the river side and carried downstream as far as required for the present works. The head obtained on the turbines is 11 feet, and the power is utilized by the Oldtown Woolen Company, which has an 8-set mill; by the Public Works Company, of Bangor, for operating pumps for the public water supply, the delivery being about 600,000 gallons per day; and by the Nekonegan Paper Company, for the manufacture of pulp.

The next privilege below on the main river is that at Great Works, owned by the Penobscot Chemical Fiber Company, which manufactures about 25 tons of wood pulp a day. The fall amounts to 14 feet, and the company operates 1,040 horsepower of turbines on the west bank, and occasionally a single wheel of 146 horsepower on the east bank. Power is also leased to Messrs. Mullen & Engel for a sawmill having a capacity for manufacturing 20,000,000 feet of lumber during the season.

On the Stillwater Branch there are three dams. The uppermost dam is at the village of Stillwater (ward 5, Oldtown), where a fall of 18 feet is obtained. The entire privilege is owned by the Orono Pulp and Paper Company, and is not at present used. The second and third dams are close together, and but little above the confluence of the Stillwater Branch with the main river. They are in the town of Orono, between Orono village, on the west bank, and what is locally known as Webster, on the east bank. The principal use of power is by a pulp mill of the International Paper Company, which combines the fall past both dams into a single fall, amounting to 26 or 27 feet, and has 3,000 horsepower of turbines installed. In the low stages of late summer flow not more than half that amount of power is obtained. The pulp is manufactured into paper on the opposite, or Webster, bank by the same company. At the paper mill the lower fall only is used, and 300 horsepower of turbines is installed. Power is also utilized at these dams for the sawmills of William Engel & Company and Adams & Company, which together manufacture from 12,000,000 to 20,000,000 feet of lumber annually, and at Mansfield & Company's shop, for the manufacture of cant dogs.

Passing below the junction of the Stillwater Branch with the Penobscot, the first privilege is that at the point locally known as Basin Mills, in the town of Orono. Here a long log dam across the principal channel diverts water, through a small channel formed by an island, to the sawmills of James Walker & Company, the continuation of the channel serving as a tailrace, and the conditions thus being peculiarly favorable for the safe and convenient utilization of the river. The head obtained is 10 feet, and about 13,000,000 feet of lumber is manufactured each season.

The next dam is 3 or 4 miles farther downstream, at Veazie, about 5 miles above Bangor. Here the power was originally utilized by sawmills, which have now been discontinued and succeeded by the extensive electric plant of the Public Works Company of Bangor. The working head obtained on the turbines ranges from 7 to 11 feet, according to the stage of the river in different seasons. Under the larger head the wheels at present installed furnish an aggregate of 1,650 horsepower, 1,500 horsepower of which is used for generators and 150 horsepower for pumps furnishing the water supply of Veazie and Brewer. There is a steam plant of the same capacity as the turbines, for some steam power is necessary at times in the summer. The electricity developed at this station is utilized for street lighting at Brewer, a town across the Penobscot from Bangor, for private incandescent and arc lighting in Bangor, and for operating the city electric car lines in Bangor as well as the suburban lines running northward to Oldtown and southward to Winterport.

The final water privilege on the Penobscot is about a mile above the business portion of Bangor, and is utilized for the municipal water supply and electric-lighting plant of that city. There is considerable oscillation below the dam, due to the tide, and the head on the turbines ranges from 4 to 8 or 9 feet, according to the stage of the river and the tide. There are at present five turbines in use, rated at 125 horsepower each under an 8-foot head. One of these is used continuously for operating the mechanical filter plant; four are needed during the day for the general demands of pumping, while at night two are devoted to the street lighting of Bangor. Considerable improvements and enlargements of the plant are in progress.

The figures at hand for the volume of the lower river are few, and those for the fall are neither definite nor probably very accurate. The latter, however, seem to give a fall from the head of the Stillwater Branch above Oldtown to mean tide at Bangor of from 80 to 85 feet. Combining with this fall the figures of flow given on pages 37–38, it appears that the power of this portion of the river at practically its lowest stages is equivalent to from 18,000 to 20,000 net horsepower continuous use for the twenty-four hours. Although the actual power now employed can not be stated, it is evident that the full power of the river is far from being utilized. Of the 80 feet or thereabouts of fall mentioned, only about 56 feet is embraced in the falls at the dams on the main river, the remainder being represented chiefly at the scattered rips between the head and the foot of the Stillwater Branch. Whether a portion of the latter power could be utilized to advantage in an independent privilege, or to what extent it could be incorporated in existing privileges, can only be determined after further investigation.

ARTIFICIAL CONNECTION BETWEEN ST. JOHN AND PENOBSCOT RIVERS.

So low are the divides between the Upper Penobscot and the St. John and Kennebec basins that a diversion of water to or from the former river is comparatively easy. More than forty years ago an artificial connection was established between the upper waters of the Alleguash, a tributary of the St. John, and the East Branch of the Penobscot. This was brought about by means of a dam at the northern or outlet end of Chamberlain Lake, a feeder of the Alleguash. The waters of that lake were thus turned back through two connecting lakes, Telosmis and Telos, and from the latter, through an artificial cut, to Webster Lake, in the Penobscot Basin. There was also a dam farther down the Alleguash, at the foot of Churchill Lake, flooding the latter back into Heron Lake, from which locks permitted the floating of logs up into Chamberlain Lake and thence to the Penobscot; but these works have long since gone to decay. The dam at the outlet of Chamberlain Lake and that at Telos Lake, however, are still in use. At the time of the spring drive the waters of Chamberlain Lake are turned through the Telos cut into the East Branch of the Penobscot to facilitate the passage of the drives down that river. At the close of the driving season the gates at the Chamberlain dam are opened, and the water of that lake is permitted to pass both ways. All timber, therefore, which is delivered below Chamberlain Lake on the Alleguash waters must go down the St. John, while that delivered at Chamberlain Lake, although it can go either way, is driven down the Penobscot to market.

The headwaters of the Penobscot and of Moosehead Lake, the largest lake in the Kennebec Basin, are only 2 or 3 miles apart, and it was once planned to build a sluiceway to unite them. This sluiceway was never constructed, however, but a traveling endless chain was installed to haul the logs from Meadow Pond, into which the water was set back by a dam across the Penobscot. From this pond the logs were elevated by an endless chain to the upper end of a V-shaped sluiceway which leads down the southern slope to Moosehead Lake. It is said that when this carrier was in use one-third of a million feet of lumber a day was thus transported.

FLOW.

No extended record of the discharge of Penobscot River has been kept. Few figures of its flow have been published, and these are of little value, being isolated measurements accompanied by few data as to the relation existing between the flow determined and that at high and at low water. In the fall of 1884 Prof. George H. Hamlin, of the University of Maine, made measurements of the main stream at Orono, also of the East and West forks of the Stillwater Branch at the foot of

Orono Island. These measurements were made on September 20, 22, and 23, with subsurface floats, and the discharge was found to be 3,480 cubic feet per second, corresponding to 0.48 cubic foot per second for each of the 7,240 square miles of tributary drainage area. About 85 per cent of the discharge was through the main river. The result thus obtained was considered by Professor Hamlin to represent the average extreme low-water discharge.

On September 7, 1886, the East and West forks of the Stillwater Branch were measured in the same manner, and on October 23, at substantially the same stage of water, the main river was measured about a quarter of a mile below the works of the Penobscot Chemical Fiber Company. The Ellis current meter was used for these measurements, and the total discharge of the river was found to be 2,470 cubic feet per second, equivalent to 0.34 cubic foot per second per square mile. This discharge Professor Hamlin regards as corresponding to extreme low water. He states that the river has at rare intervals been lower than it was at that time, but only slightly lower. In the measurements of both 1884 and 1886 it is believed that the results obtained represented the average flow for twenty-four hours.

A record of the flow of the river at the Sunk Haze Rips, near Costigan, Me., was kept from September 15, 1899, to September 22, 1900. The rating curve was constructed from tube-float measurements made by Mr. George F. Hardy and reported to the supreme court of the State on October 23, 1901. The area of the drainage basin at the Sunk Haze Rips is 7,450 square miles. The results of these measurements are given in the following tables:

Daily discharge, in second-feet, of Penobscot River at the Sunk Haze Rips, near Costigan, Me., for 1899.

Day.	Sept.	Oct.	Nov.	Dec.	Day.	Sept.	Oct.	Nov.	Dec.
1		3,450	3,300	4,800	18	2,350	2,330	4,400	10,150
2		4,250	5,600	5,100	19	2,900	2,330	5,100	10,150
3		5,100	10,850	5,950	20	2,380	2,390	5,250	10,500
4		3,900	12,200	8,000	21	2,450	2,430	5,950	11,000
5		3,550	11,000	8,750	22	2,750	2,350	6,240	11,250
6		3,360	10,850	8,650	23	2,670	2,100	6,700	11,200
7		3,190	10,500	8,650	24	2,850	2,670	6,800	10,300
8		3,300	14,000	7,700	25	2,450	2,420	6,450	9,850
9		3,200	9,090	8,500	26	3,410[a]	2,320	5,600	9,750
10		3,100	8,300	7,900	27	3,300[a]	2,100	5,100	9,200
11		3,100	7,620	7,440	28	3,140	2,330	5,250	8,850
12		2,950	7,300	7,230	29	3,020	2,160	5,600	8,570
13		2,750	6,020	9,400	30	3,190	2,000[a]	5,800	8,400
14		2,630	6,240	11,500	31		2,550		9,430
15	2,830	2,630	6,100	11,500					
16	2,640	2,330	6,100	10,000	Mean	2,808	2,764	7,170	9,014
17	2,600	2,410	5,800	9,750					

[a] Shut down at Montague.

Daily discharge, in second-feet, of the Penobscot River at the Sunk Haze Rips, near Costigan, Me., for 1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	9,500	36,000	47,600	40,300	59,400	34,300	11,900	14,100	5,950
2	10,000	35,800	47,500	39,600	54,800	30,300	12,200	13,550	5,950
3	10,500	33,700	45,600	41,300	54,100	36,300	11,900	12,900	5,950
4	11,700	32,200	44,400	44,500	61,200	41,600	11,500	12,700	5,950
5	11,900	31,700	42,300	46,600	72,500	38,200	11,700	12,400	6,100
6	11,200	31,800	41,400	43,800	74,700	34,700	12,500	12,400	6,950
7	11,000	31,500	39,400	42,600	69,900	32,300	12,800	12,050	6,800
8	10,000	31,000	37,700	45,300	66,900	30,300	12,800	12,050	6,250
9	10,150	30,000	36,500	48,800	63,600	27,400	13,200	12,050	5,800
10	10,150	29,200	35,100	44,500	63,000	24,200	14,100	12,050	5,400
11	10,150	27,200	33,600	48,800	61,700	24,200	14,100	12,050	3,140
12	12,600	26,200	32,650	36,600	58,000	23,900	14,100	13,400	3,270
13	13,600	27,150	31,100	38,000	53,400	22,300	14,400	13,200	3,100
14	13,150	29,800	30,500	42,600	49,400	22,000	13,900	12,700	3,270
15	12,750	43,000	29,800	44,500	50,100	18,400	14,600	12,400	3,350
16	12,200	51,000	29,200	46,100	54,100	19,000	14,000	13,400	3,250
17	11,950	52,400	34,800	48,100	50,700	17,500	11,900	12,400	3,050
18	12,400	49,900	44,100	49,400	50,800	14,600	13,200	12,050	3,020
19	12,200	47,300	33,200	54,800	48,800	13,600	16,900	11,900	2,800
20	11,800	45,000	32,500	62,400	54,100	12,600	21,400	11,700	2,620
21	11,850	43,000	62,700	62,000	62,400	10,500	18,700	11,200	2,880
22	12,600	39,700	62,500	75,100	55,700	9,700	14,400	10,450	.....
23	13,600	38,300	61,300	74,700	61,700	12,200	12,900	9,000	.....
24	14,850	35,700	59,500	71,400	60,000	10,150	11,300	7,650	.....
25	15,650	34,800	58,000	69,600	57,800	9,400	11,300	6,350	.....
26	16,300	38,300	55,500	67,500	55,000	8,300	12,200	4,850	.....
27	19,000	44,400	54,800	65,300	50,800	8,150	15,100	6,600	.....
28	27,500	47,300	51,500	61,700	49,800	7,800	15,100	6,450	.....
29	32,000	.....	48,100	59,500	47,100	9,000	14,800	6,150	.....
30	33,500	.....	44,500	56,800	44,200	10,150	14,600	5,950	.....
31	35,400	.....	41,300	.....	39,900	.....	13,550	6,200	.....
Mean	14,876	37,262	43,828	52,407	56,632	20,435	13,769	10,722	4,507

A record of the flow of the river at Milinoket has been kept during the last two years, but the results are not yet ready for publication.

The only extended rainfall record in the basin is that for Orono, showing 46 inches yearly average for the period 1871 to 1891. A record of the rainfall at Milinoket has been kept since 1899. During the summer of 1901 the United States Geological Survey established a rain gage at Wytopitlock, in this basin, with the idea of obtaining information as to the precipitation nearer the headwaters of the stream. A gaging station was also established at Montague, on the main stream, where records of gage heights are made daily, and current-meter measurements of the discharge as often as required to construct a reliable rating curve. From these data the flow of the river on each day of the year can readily be computed.

KENNEBEC RIVER.

DRAINAGE BASIN.

Kennebec River is one of the best streams in the United States for the development of water power. Its basin lies between those of the Androscoggin and the Penobscot, and extends from the Canada line to the ocean. (See Pl. V, p. 28.) The basin measures 150 miles in length, and varies in width from 50 to 80 miles in the main portion, embracing

a total area of 6,330 square miles. Of this area 1,250 square miles are tributary to Moosehead Lake. The general elevation is less than that of the Androscoggin Basin, though near the center of the area Saddleback, Abraham, and Bigelow mountains rise as isolated peaks to elevations higher than any mountains in the State except Katahdin.

The river rises in Moosehead Lake, though its headwaters are collected by Moose River, Roach River, and a number of smaller streams rising in the hilly, forested areas lying to the east and west of that lake. Near Moosehead the hills and highlands are well back from the lake, leaving a great open plain. The northern part of the drainage basin is broken by offsets from the White Mountains. Nearly the whole of the upper portion of the drainage area is forest covered and in its original wild state. Below the outlet of Moosehead Lake into the Kennebec the hills close in upon the river, forming a narrow, rocky chasm, with steep and precipitous sides. From Moosehead Lake to The Forks the river is a torrent, falling over a rocky bed 500 feet in a distance of 23 miles. At The Forks the waters of Dead River, which rises near the western boundary of the State at an elevation of about 2,000 feet, are joined to the main stream. Below this junction the river flows through a broad valley, with gentle slopes upon either side, still covered to some extent with forest growth, but largely cleared and with occasional cultivated farms. About 60 miles from the coast the hills again rise, though not to a considerable height. There are on the river a number of large falls, which have been developed by the construction of dams and are now used for sawmills, pulp mills, and cotton mills. These will be described later.

The prevailing rock in the northern part of the basin is slate, with a belt of sandstone to the west and a district of granite to the east of Moosehead. South of Bingham mica-schists run into the clay slate in spots, and elsewhere into gneiss, but (except where broken by intrusions of granite, as at Hallowell and Augusta), the slate prevails as far as Gardiner. Below the latter city gneiss predominates, with stretches of mica-schists on the east bank. The surface materials are finely pulverized, and water-retaining sands and gravels are more abundant in the northern part, succeeded by a greater proportion of loam and clay to the southward.

driving it is desirable to open the gates at the lakes in the spring and early summer, when the normal flow of the stream is already large, so as to flush the logs down to the mills (see Pl. VIII, *A*); while the economical use of stored water for power requires it to be held back in the lakes until midsummer and gradually drawn down from that time through the fall and winter. Moosehead Lake fills during the winter and spring largely, with the melting of the snow, the last of which is usually wasted and forms part of the freshet flow. Between about May 15 and June 1, when logs in sufficient numbers arrive at the lake dam, usually about three days after the ice leaves the lake, the outlet gates are opened, and from that time water is steadily drawn.

An association of manufacturers upon the river has been chartered under the name of of the Kennebec Water Power Company, with a view to the systematic development and control of the storage of the basin. This company and the Kennebec Log Driving Company have made a number of improvements on the river, such as blasting and clearing out the channel of the East Branch, by which means they have been able to drive the logs with less water. While formerly from 5,000 to 6,000 cubic feet per second were used, logs are now driven with from 3,000 to 4,000 cubic feet. This enables them to reserve from 4 to 4½ feet of water in the lake after the drive has reached Augusta, while formerly only 2 feet were left in the lake. The total amount expended by the Kennebec Water Power Company during the last four or five years for improvements and surveys of the Kennebec watershed was $27,259.58. They gave $20,000 to the Kennebec Log Driving Company as their part of the expense of rebuilding the dam at Moosehead Lake. At present the storage in the lake is controlled by the Kennebec Log Driving Company, but after the drive the control of the water is put into the hands of a member of the Kennebec Water Power Company.

The dams at the two outlets, known respectively as the east and west outlet, are of log crib work, filled with stone, and buttressed by heavy piers of similar construction. (See Pl. VII, *A* and *B*.) Nominally the dams have raised the lake surface 7½ feet above the original low-water level, but it can not now be drawn much lower than within a foot of that level, and the actual yearly range between high and low water is from 5½ to 6 feet. The tributary drainage is not entirely controlled, and a large wastage past the dams occurs nearly every year.

The dam at the east outlet has been rebuilt recently and is now in excellent condition. A plan is in contemplation to raise it 2 feet, thereby greatly increasing the storage of the lake. This additional storage could be used for running the logs in the spring and early summer, and the remainder would be available for augmenting, for

manufacturing purposes, the low-water flow. A careful survey of the lake shores has been made by the Kennebec Water Power Company, and flowage maps have been prepared showing the new lake shore if the dam be raised 2 feet. The shore in most places rises rather rapidly, so that the water will not extend far over the land, yet in the aggregate the flooded areas will be large and the project expensive. The expense is considered justifiable, however, owing to the great increase that would take place in the value of the water powers below.

WATER POWERS.

The sources of the streams forming the Kennebec are at elevations of from 1,800 to 3,000 feet, while Moosehead Lake is 1,023 feet above tide level. The distance from the source of Moose River to the sea is 227 miles, following the stream, while from Moosehead Lake to tide water at Augusta the distance is 112 miles. This gives a mean descent of 9.1 feet to the mile throughout the water-power portion of the river, which is a greater fall than any other large river of the State has concentrated in a proportional distance. Elevations at various points along the river are given in the following table:

Fall in Kennebec River.

Locality.	Distance from mouth of river.[a]	Height above mean tide.	Fall between points.	Distance between points.	Average fall per mile between points.	Authority.
	Miles.	*Feet.*	*Feet.*	*Miles.*	*Feet.*	
Canadian Pacific Railway crossing at outlet of Moosehead Lake.	142	[b] 1,034				P. Alex. Peterson, chief engineer Canadian Pacific Railway.
			720	56	12.8	
Somerset Railway crossing at Carritunk Falls.	86	[c] 314				John Ayer, president Somerset Railway.
			69	11	6.3	
Somerset Railway crossing at Madison.	75	[c] 245				Do.
			98	8	12.2	
Somerset Railway crossing at Norridgewock.	67	[c] 147				Do.
			81	22	3.7	
Maine Central Railroad upper crossing at Waterville.	45	[d] 66				H. C. Robinson, assistant engineer Maine Central Railroad.
			66	19	3.5	
Augusta	26	0				

[a] Measured on Colton's map of Maine.
[b] Canadian Pacific Railway levels (high water 1,038.6; low water 1,033.6).
[c] Adjusted for water surface above dam and for mean tide from profile elevation of Somerset Railway.
[d] Adjusted for water surface from elevation of track, 87 feet above mean tide.

From Moosehead down to tide water the river offers many favorable locations for power development. At seven places the fall is already utilized, and there are several other places where economic developments could be made. The chief hindrance to improvements has been the lack of transportation facilities, and this feature has

not yet been entirely overcome. The river is navigable from its mouth to Augusta, a distance of 40 miles, and a railroad follows the stream as far as Bingham, 20 miles south of The Forks, having east and west connections at Waterville. About 300 yards below the east outlet of Moosehead Lake the Canadian Pacific Railway crosses the river. The stretch of country between Bingham and Moosehead, about 43 miles, is without any means of transportation. From The Forks north there is hardly what might be called a roadway, a trail through the forest being the only connection with Moosehead. It is, however, probably only a question of time when the railroad will be pushed farther north, giving transportation to power plants which in all probability will be established near the headwaters of the river.

At the east outlet there was formerly a small sawmill utilizing the fall at the outlet dam, but when (in 1890) a new wooden dam was constructed a little farther downstream the sawmill was abandoned.

Where the river leaves Moosehead Lake it is a swift-flowing stream about 300 feet in width, with rough, rocky bottom and banks. For about 4 miles the character of the stream remains much the same, the aggregate fall in that distance being 93 feet. The river then widens out into Indian Pond, a sheet of water about 4½ miles long and a half mile wide. At the head of this pond the stream from the west outlet of Moosehead Lake joins the main river. The discharge of this outlet is comparatively small and is controlled by a small wooden dam (shown in Pl. VII, *B*), with gates for regulating the flow. Below the pond the river has a continuous and decided fall for a distance of about 7 miles through a rocky gorge with side walls from 20 to 50 feet high. Throughout this portion of its course the water falls over many precipitous ledges, and the river has the characteristics of a mountain torrent. There is a large amount of power that could be utilized in this 7-mile stretch, the flow and fall being large, the sites favorable for the construction of dams, and good building materials at hand. The chief disadvantage is the lack of transportation facilities, though this could be remedied by the extension of the Somerset Railway north from Bingham.

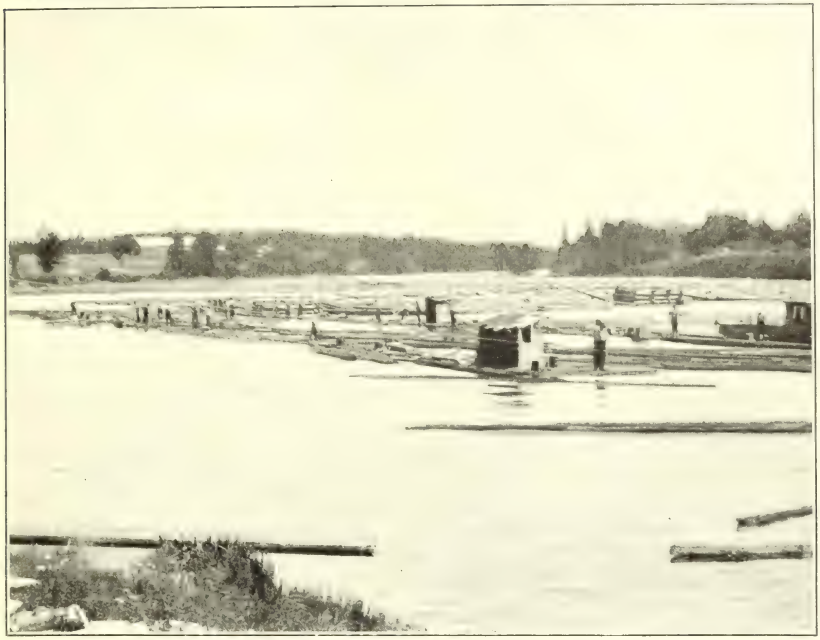
As has been stated, there is a fall of about 500 feet between Moosehead Lake and The Forks, a distance of 23 miles. Between The Forks and Carritunk Falls there is a fall of about 200 feet; from Carritunk Falls to Madison, a distance of 11 miles, the river falls about 80 feet; from Madison to Norridgewock, a distance of 13 miles, the fall is about 100 feet; from Norridgewock to tide water the average fall is much less, being about 3½ feet to the mile, and largely concentrated at a few points, partly by nature and partly by dams built across the river, as at Skowhegan, Shawmut, Fairfield, Waterville, and Augusta.

The seven powers that are at present utilized are between Carritunk Falls and Augusta, and aggregate 24,000 horsepower, covering about 142 feet of the 314 feet total fall of the river between those points. The uppermost of these powers is that of the International Paper Company, at Carritunk Falls. That company has about 3,500 horsepower of turbines installed. There is a natural cascade at this point, with a pitch of 28 feet through a narrow gorge, above and below which the river widens out. The dam was built in the winter of 1891, and makes the available fall 30 feet.

Passing downstream the next utilized power is at Madison, where during normal stages of the river a head of 20 feet is utilized. The water wheels on this power aggregate about 3,000 horsepower, although that amount is not available at all times, owing to lack of water. At present several concerns are using power at Madison, viz: The Great Northern Paper Company, manufacturing newspaper and sulphite fiber; the Indian Spring Woolen Company and the Madison Woolen Company, both manufacturing woolen goods; and the Madison Pumping Station. The amount of power used by the Great Northern Paper Company varies somewhat, according to the flow of the river. They use about 1,200 electrical horsepower at all times, and have grinder units installed requiring a maximum of about 2,000 horsepower. The electric plant is run throughout the year at full capacity, while the grinders probably average about half power throughout the year. The woolen companies are supposed to use about 400 horsepower each.

There is a natural fall of more than 80 feet, in pitches and rapids, in the river near Madison, so that only a small portion of the power available in that locality is employed. The Great Northern Paper Company has prepared plans for developing two falls just below the town, one of 20 feet and the other of 43 feet. The 20-foot fall is at Old Point, near the Norridgewock town line, and will be used entirely for electrical power. A dam about 640 feet long will be built, and sufficient apparatus installed to generate 3,000 horsepower. At the 43-foot fall a masonry dam having a height of from 10 to 30 feet and a length of crest of 850 feet will be built. This power will be used entirely for grinding wood pulp. Wheels to generate 13,000 horsepower will be installed, with the idea of storing the product during high water and running whatever part of the plant is possible during low water.

The next dam is at Skowhegan, where the power is controlled by the Skowhegan Water Power Company. The fall is 17 feet, and 28 water wheels of an aggregate capacity of 5,100 horsepower are in use at the various works. Of this amount 2,900 horsepower is employed in pulp manufacture, 750 horsepower exclusively for electric lighting and power, and the remainder by grist, saw, planing, and woolen



A. LOG BOOM ON KENNEBEC RIVER ABOVE MADISON FALLS.

B COTTON MILLS OF EDWARDS MANUFACTURING COMPANY AT AUGUSTA.

mills, and sash-and-blind and scythe factories, some of the turbines operating factories by day and electric lights by night.

At Somerset Mills, in the town of Fairfield, there is a log dam 12 feet high and about 1,300 feet long, furnishing power for two sawmills and a planing mill. The dam and the sawmills are owned by the Lawrence, Newhall & Page Company. They have eight or ten wheels, developing 1,000 horsepower. At the same town there is a fall of 10 feet utilized by pulp mills, an electric-light plant, a furniture factory, and a woolen mill. This dam is owned and controlled by the Fairfield Junction Mills and Water Power Company.

Water power on the Kennebec is developed more extensively at Waterville and Winslow than elsewhere on the river. The upper privilege, formerly known as the College Rapids, is utilized by the Hollingsworth & Whitney Company, paper manufacturers, and embraces a fall of 20 feet, operating 46 turbines of an aggregate capacity of 6,358 horsepower. The lower privilege, at Ticonic Falls, is owned by the Lockwood Company, at whose cotton mills about 2,400 horsepower is used. A dam 750 feet long raises the river surface 7 feet, and a further natural fall of 13 feet over a slate ledge gives a total head of about 20 feet.

At Augusta, the head of tide water, a crib-work dam 17 feet high and 950 feet long has been constructed, ponding water 17 miles upstream, or to Waterville. On the west bank the Edwards Manufacturing Company uses about 2,500 horsepower in its cotton mills (shown in Pl. VIII, *B*), while on the east bank 1,500 horsepower is employed by the Cushnoc Paper Company and the Kennebec Light and Heat Company, the latter furnishing the municipal lighting for Augusta, Hallowell, Gardiner, and Togus. The fall is affected somewhat by the rise of the tide.

FLOW.

The natural flow of the Kennebec is somewhat disguised by the regulation at the Moosehead Lake outlet. The storage capacity of that lake is very large, and the effect upon the flow of opening and closing the gates is marked. If this regulation were designed entirely to benefit the power plants the flow of the river could be made far more constant than at present. The fact that the water is required for log driving perhaps gives a great surplus to the manufacturers in the log-driving season, but draws the lake down so that the available storage is much lessened at the beginning of the dry season. Raising the dam at the Moosehead Lake outlet 2 feet, as contemplated, would furnish a supply for log-driving purposes and permit sufficient storage to greatly increase the low-water flow of the river.

An intelligent study of the possibilities of storage, however, requires that data should be available showing the amount of rainfall, the size

and character of the drainage area, and the variations in the flow of the river. Unfortunately, in Maine very little attention has been paid to the determination of the rainfall. In the Kennebec Basin a rainfall gage has been maintained at Fairfield and the records from this gage have been used in the tables on the following pages, but absolutely no records have been obtained on the headwaters of the main river or its tributaries. During the summer of 1901 a rain gage was established at Kineo, on Moosehead Lake, by the Kennebec Water Power Company, and in the fall of the same year rain gages were placed by the United States Geological Survey at The Forks, at Roach River, at Northeast Carry, and at Jackman, and gaging stations were established at The Forks and at North Anson on the Kennebec, at The Forks on Dead River, at North Anson on Carrabassett River, and at Roach River on Roach River.

Topographic maps of Kennebec River and its drainage basin from the coast as far north as Skowhegan have been made by the Geological Survey, but unfortunately the headwaters have not yet been surveyed. This topographic work, however, will be pushed northward as rapidly as the appropriations permit.

The only long-continued observations of the volume of the river are those which have been made at Waterville, by the Hollingsworth & Whitney Company, who kindly furnished the results for publication herein. The works of that company are above the mouth of Sebasticook River. The tributary drainage area of the Kennebec at that point is about 4,410 square miles, as measured on Colton's map of Maine. Of the figures for discharge, those prior to June 20, 1893, are from computations by weir formula of the quantity flowing over the dam; those subsequent to June 20, 1893, at which time the mill began running, are from computations of the flow through the turbines, based upon assumed ratings, to which has been added any excess passing over the crest of the dam, the length of which is 734 feet. The figures really represent the flow at 12 o'clock noon of each day, that hour having been chosen, after investigation, as a time when the flow is least affected by storage at dams upstream, and as giving most nearly the average for the day.

On December 15, 1901, occurred one of the highest floods known on the Kennebec. The maximum discharge of the river at Madison was computed by Mr. H. S. Ferguson, C. E., and found to be 105,000 cubic feet per second. The length of the present masonry dam is 550 feet. The depth of flow over the crest during the height of the freshet was 14½ feet. At 8 a. m., Sunday, December 15, the water was just flowing over the crest; at midnight that day it reached a maximum height of 14½ feet, and by 10 a. m. of the next day it had dropped to about 9 feet on the crest of the dam. It is estimated that the drainage area at Madison is about 2,850 square miles, and it is reported that during

the freshet most of the gates at the Moosehead Lake outlet were closed.

The results of the measurements at Waterville are given in the following tables and are shown graphically in figs. 1 to 5, inclusive. An inspection of the tables will show that while the dry-weather flow of the river is not nearly so low nor the floods so violent as on most Atlantic streams, yet there are large spring rises, due to the melting of the snow and to spring rains, which the capacity of the lakes as now artificially controlled is not sufficient to store. The rises are frequently sudden, as can be seen by the tables. Thus, the discharge on May 17, 1893, was 30,700 cubic feet per second; on the following day it was 83,500 cubic feet per second; and on the next day it dropped to 46,100 cubic feet. Again, in April, 1895, the discharge rose from 24,000 cubic feet per second on the 14th to about 86,000 cubic feet per second on the 15th, being nearly quadrupled. It will be seen that this river seldom has a discharge at Waterville of less than 1,100 cubic feet per second, or about 0.25 cubic foot per second per square mile.

Daily discharge, in second-feet, of Kennebec River at Waterville, Me.

[Drainage area, 4,410 square miles.]

1892.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1				3,530		11,840	17,355					
2				4,730	7,920		20,030					
3				10,260		11,840						
4				19,100	6,310		29,985					
5				25,250								
6				22,980	8,950	11,515						
7				28,150								
8				24,830		8,200						
9				22,810	9,660							
10						7,925						
11				18,090	5,900							
12												
13				11,195	7,650	7,375						
14											a 545	
15				8,660		7,100					a 395	
16											a 670	
17					6,940	8,490					a 639	
18				6,940	6,580						a 568	
19											a 961	
20				6,465	5,310	10,260					a 1,449	
21											a 1,488	
22			2,470	7,530		17,355					a 1,112	
23				9,835	7,215							
24			2,430			19,640					a 958	
25			2,250		13,750	21,615					a 1,399	
26			2,220								a 2,296	
27			2,000	13,160	10,750	19,250						
28			2,325			19,640						
29			2,390	8,780		29,990						
30			2,730		12,160	20,030						
31			3,080									

a These figures are for the year 1891. The closing of gates at Moosehead Lake is said to have caused the small discharge here recorded.

Daily discharge, in second-feet, of Kennebec River at Waterville, Me.—Continued.

1893.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	2,350	2,500	4,100	21,700	13,200	10,840	1,940	2,490	.....	1,980	2,780
2	.....	2,250	2,500	4,250	21,200	16,250	.....	2,330	2,140	1,980	1,980	2,580
3	.....	2,200	2,450	4,500	27,600	15,200	9,990	2,380	.....	1,980	1,980	.....
4	.....	2,100	2,400	4,400	24,700	.....	11,230	2,360	1,890	1,710	1,980	.....
5	.....	2,100	2,400	3,700	60,500	13,800	8,840	2,290	1,890	1,980	.....	1,440
6	.....	2,200	2,400	3,700	46,500	15,250	9,740	.....	1,890	1,980	1,980	1,440
7	.....	2,300	2,350	3,600	36,700	16,250	8,410	2,240	2,260	1,980	2,250	1,440
8	.....	2,250	2,350	3,600	30,200	18,200	8,410	2,210	2,360	.....	1,980	1,440
9	.....	2,100	2,325	6,400	26,300	23,500	.....	2,360	2,680	1,980	1,980	1,440
10	.....	3,000	2,300	9,200	25,200	15,900	8,260	2,360	.....	1,980	1,980	.....
11	.....	2,400	2,300	12,400	27,000	.....	8,710	2,290	2,160	1,710	1,980	1,440
12	2,000	2,550	2,300	15,000	31,700	16,250	6,510	2,290	2,380	1,440	.....	1,440
13	2,100	2,600	5,400	16,500	31,300	23,200	6,410	.....	2,190	1,780	1,980	1,440
14	2,300	2,550	8,000	16,500	54,500	20,500	6,040	2,240	2,410	1,980	1,980	1,440
15	2,500	2,500	11,300	18,200	43,100	18,200	5,540	2,290	2,340	4,000	1,980	1,440
16	2,600	2,400	7,400	16,500	34,100	15,200	.....	2,430	2,175	3,050	1,980	1,440
17	4,800	2,300	6,300	14,100	30,700	13,200	4,840	2,210	.....	2,550	1,980	.....
18	5,000	2,200	6,100	14,000	83,500	13,200	4,490	2,150	1,710	2,550	2,250	1,710
19	4,200	2,100	5,700	14,100	46,100	11,200	3,660	2,290	1,710	1,980	.....	1,710
20	3,200	2,200	5,600	16,300	34,500	11,000	3,270	.....	2,200	2,250	2,250	1,440
21	2,100	2,350	4,600	14,500	.....	12,000	3,590	2,240	1,710	1,980	2,520	1,440
22	1,900	2,450	3,900	12,300	24,300	14,480	3,490	2,205	1,710	.....	2,250	1,440
23	2,100	2,350	3,600	13,800	22,800	13,640	.....	2,180	1,710	1,980	2,550	1,440
24	2,200	2,200	3,600	15,800	21,200	11,840	3,170	2,153	.....	1,980	2,480	.....
25	2,300	2,400	4,000	14,500	19,800	.....	2,830	2,295	1,710	3,380	1,980	.....
26	2,200	2,400	4,400	14,600	17,000	14,270	2,440	2,390	1,710	2,450	.....	1,440
27	2,200	2,450	4,400	14,200	16,300	14,000	2,380	.....	1,980	1,980	1,980	1,590
28	2,300	2,500	4,300	14,600	15,200	15,100	2,360	2,340	1,980	3,630	2,080	1,440
29	2,300	.....	4,200	14,800	14,550	14,600	2,240	2,310	1,710	3,530	3,980	1,590
30	2,350	.....	4,100	19,800	13,600	13,500	.....	2,230	1,980	3,280	3,630	1,590
31	2,400	.....	4,000	.....	13,900	.....	2,440	2,430	.....	2,280	.....	.....
Mean	2,650	2,350	4,180	11,660	30,520	15,290	5,770	2,270	2,040	2,330	2,230	1,580

1894.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1,470	1,910	1,740	.....	15,650	11,190	.....	3,305	2,253	2,181	3,806	1,570
2	1,640	1,910	1,740	4,496	14,510	12,930	7,030	3,240	1,125	1,923	7,295	.....
3	1,640	1,740	1,740	4,496	14,090	.....	6,860	3,143	2,312	1,915	5,619	2,187
4	1,640	.....	.....	4,370	13,220	12,930	.....	3,218	1,871	1,930	10,512	2,194
5	1,640	1,910	2,010	4,370	13,220	10,400	10,020	.....	2,207	1,896	9,486	2,213
6	1,640	1,910	1,740	5,473	.....	9,070	8,570	3,087	1,824	1,655	7,381	1,869
7	.....	1,740	1,910	4,720	12,280	9,070	7,665	3,019	2,209	.....	5,606	2,193
8	1,640	1,740	2,370	.....	10,100	8,520	.....	3,019	2,185	1,897	4,651	2,128
9	1,470	1,740	3,040	5,278	8,550	6,910	7,055	3,285	1,140	1,913	3,937	1,245
10	1,640	1,740	4,643	5,655	7,226	.....	6,336	3,045	2,293	1,913	3,739	1,937
11	1,640	.....	.....	5,950	7,050	5,900	6,674	3,050	2,034	5,553	3,040	1,211
12	1,470	1,740	5,390	6,980	6,110	.....	6,674	.....	2,818	6,738	3,636	1,694
13	1,640	1,740	5,390	7,170	.....	6,280	6,674	3,250	2,280	5,017	3,476	1,819
14	.....	1,740	6,220	6,980	5,840	5,900	6,336	3,125	2,309	8,387	2,782	2,386
15	1,470	1,740	5,586	.....	6,820	6,010	.....	3,005	2,341	9,036	2,500	2,600
16	1,640	1,740	4,460	12,150	7,410	5,900	6,674	3,010	.....	3,829	2,661	2,275
17	1,640	1,740	4,855	13,310	9,935	.....	6,046	3,110	2,183	7,527	2,489	2,513
18	1,470	.....	.....	20,640	9,935	.....	5,765	3,060	2,136	6,418	2,152	2,466
19	1,640	1,740	4,140	21,760	10,915	5,520	5,100	.....	1,883	5,088	2,631	2,331
20	1,640	1,740	5,405	22,910	.....	9,565	5,550	3,230	1,885	4,253	1,984	2,326
21	.....	1,760	3,802	26,860	13,540	10,055	4,885	3,050	12,102	3,231	2,446	2,205
22	1,640	1,760	6,660	.....	8,250	5,490	.....	2,915	6,659	3,730	2,502	2,208
23	1,640	1,810	6,395	35,280	6,100	6,265	3,680	2,825	4,673	3,576	2,495	1,229
24	1,640	1,810	5,215	33,680	6,360	.....	3,565	3,070	4,143	3,315	2,487	1,912
25	1,910	.....	.....	29,130	6,580	3,930	3,670	2,555	2,646	2,549	2,786	.....
26	1,910	1,760	4,855	25,210	10,560	3,781	3,830	.....	2,571	2,605	2,484	.....
27	1,910	1,740	4,184	21,980	.....	3,710	3,830	2,855	2,509	2,854	2,461	1,831
28	.....	1,740	4,180	20,680	8,690	10,480	3,830	2,494	2,378	.....	2,515	1,770
29	1,640	.....	3,895	.....	7,480	8,985	.....	2,615	1,918	2,859	1,444	1,657
30	1,640	.....	3,620	17,450	7,960	8,070	3,415	2,294	467	2,458	1,645	904
31	1,640	.....	3,510	.....	10,000	.....	3,345	2,400	.....	2,452	.....	1,227
Mean	1,640	1,780	4,020	14,680	9,570	7,790	5,720	2,970	2,740	3,750	3,760	1,930

Daily discharge, in second-feet, of Kennebec River at Waterville, Me.—Continued.

1895.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1,135	2,214	1,685	2,176	13,227	9,818	5,042	3,153	1,792	1,106	1,081	5,904
2	1,599	2,208	1,687	2,205	11,967	9,314	4,315	3,062	2,867	1,149	1,347	4,682
3	1,655	1,723	1,252	2,406	11,461	8,408	4,278	3,063	2,560	1,130	1,870	8,378
4	1,694	2,174	1,720	2,638	12,172	7,979	3,784	1,576	2,226	1,110	1,421	5,842
5	1,608	2,444	2,229	6,164	11,934	7,364	4,062	3,015	2,212	1,152	2,201	3,519
6	1,780	2,077	2,145	7,691	12,584	7,370	3,844	2,738	2,200	.....	1,946	2,723
7	1,678	1,854	1,956	9,286	12,764	7,425	4,429	2,610	2,155	1,128	1,708	3,273
8	1,947	1,718	1,951	9,325	10,917	7,623	4,499	2,816	1,438	1,104	1,657	2,301
9	1,894	1,622	1,949	24,407	12,074	6,166	4,039	2,580	2,250	1,126	1,426	3,393
10	1,896	1,397	1,368	54,192	7,848	6,418	4,072	2,382	2,502	1,356	5,125	3,089
11	1,889	1,983	1,683	27,999	9,630	5,852	3,995	1,529	2,256	1,109	9,595	1,105
12	1,864	1,946	1,920	20,858	7,920	6,454	3,934	2,690	2,209	1,121	8,351	2,598
13	1,275	1,943	1,932	19,304	11,352	4,854	3,731	2,435	1,996	.....	6,279	2,278
14	2,405	1,967	1,946	24,061	16,175	5,887	3,658	2,405	1,970	1,185	3,882	2,524
15	2,441	1,648	2,236	86,201	12,878	6,925	3,767	2,160	1,150	1,141	3,869	1,747
16	2,481	1,951	2,224	70,381	12,121	6,592	3,631	2,433	1,736	1,134	4,972	2,545
17	2,490	579	1,566	43,408	9,842	6,156	3,508	2,118	1,710	1,250	6,455	2,069
18	2,508	2,112	2,224	34,708	7,895	6,121	3,546	857	1,987	1,546	5,695	2,621
19	2,439	1,708	2,194	31,068	8,668	5,616	3,512	2,681	1,721	1,587	4,591	1,928
20	1,817	1,689	1,937	31,562	7,807	5,905	3,232	2,072	1,741	.....	4,169	2,180
21	2,439	1,361	1,965	31,363	5,863	5,641	3,257	2,357	1,707	1,353	10,949	2,536
22	2,304	1,656	1,946	29,572	5,449	4,497	2,617	2,240	1,050	1,422	11,179	3,321
23	2,332	1,606	1,977	28,511	5,515	5,075	3,151	2,199	1,139	1,428	6,694	11,026
24	2,290	.....	1,627	23,707	8,261	5,046	2,875	2,722	1,387	1,432	5,124	9,147
25	2,332	1,629	2,241	20,348	8,037	5,670	2,863	1,658	1,167	1,372	5,662	6,136
26	2,319	1,676	2,314	18,931	6,919	6,216	2,590	4,284	1,155	1,399	4,804	5,162
27	1,706	1,714	2,769	15,489	7,533	6,290	2,552	5,089	1,104	.....	9,385	5,592
28	2,433	1,927	2,600	15,929	8,119	5,708	2,096	4,890	1,145	1,115	15,900	26,673
29	2,198	.....	2,418	10,853	6,109	5,690	2,671	3,450	.....	1,355	11,623	16,118
30	2,439	.....	2,459	13,216	4,868	4,955	2,930	3,080	1,115	1,385	9,372	14,599
31	2,127	.....	1,898	.....	8,982	.....	2,678	3,102	.....	1,081	.....	19,713
Mean	2,040	1,800	2,000	23,930	9,580	6,430	3,520	2,690	1,780	1,250	5,610	6,030

1896.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3,281	2,643	6,257	5,527	29,468	7,491	4,811	3,730	2,643	2,870	3,238	8,049
2	21,881	1,292	111,246	5,861	26,601	11,004	4,374	2,696	2,611	2,975	4,259	6,844
3	17,367	2,717	52,691	6,647	25,207	6,846	4,236	3,595	1,772	3,734	4,023	5,730
4	11,482	2,522	24,810	6,442	18,064	5,891	5,578	3,597	2,577	2,275	3,757	2,200
5	6,708	2,243	13,866	5,782	26,583	5,318	5,249	3,037	2,371	5,249	3,435	2,603
6	4,153	2,236	13,170	5,709	30,879	4,961	11,678	3,044	2,129	4,567	29,865	2,545
7	3,805	2,857	11,862	5,373	29,499	4,343	11,214	3,313	6,903	3,954	23,836	3,312
8	4,329	4,634	10,323	4,998	25,090	4,391	9,685	3,468	7,978	3,277	17,040	2,851
9	2,970	3,902	8,950	5,040	22,228	4,374	8,690	.....	6,094	3,210	15,322	2,870
10	2,971	3,452	9,499	5,199	19,997	5,953	7,149	4,113	4,624	3,166	12,152	2,852
11	3,006	3,140	5,469	6,757	20,249	3,855	6,047	4,737	4,003	2,394	10,022	2,851
12	2,755	3,002	5,226	8,356	21,463	6,252	4,637	4,276	3,668	2,626	11,389	2,938
13	2,970	2,816	6,109	16,221	19,072	5,235	4,844	3,906	1,857	2,617	11,777	2,385
14	2,689	2,967	3,651	11,472	18,994	5,142	4,437	3,695	2,252	2,362	10,962	2,981
15	2,595	2,879	.....	15,989	18,066	4,679	4,289	3,414	3,002	2,388	9,319	2,874
16	2,996	2,193	3,888	46,946	16,696	4,944	4,449	2,566	2,789	2,311	8,426	2,307
17	2,513	2,829	10,129	64,700	17,981	4,549	5,121	3,197	2,396	2,384	7,947	2,272
18	2,736	2,824	3,159	61,276	14,846	4,536	5,125	3,137	2,932	2,016	7,952	1,489
19	1,568	2,758	4,087	57,188	15,227	4,219	4,495	3,178	3,590	2,319	8,136	2,303
20	2,788	2,763	6,699	52,131	13,163	4,710	4,596	3,079	1,733	2,326	7,547	1,870
21	3,000	2,781	12,922	74,469	14,782	5,352	4,391	2,858	4,313	2,352	6,572	2,547
22	2,767	2,771	3,239	60,021	13,215	6,075	4,419	2,747	4,207	4,208	5,222	2,287
23	2,593	2,162	10,025	41,711	3,976	6,655	4,374	2,759	4,147	8,956	3,749	2,047
24	2,542	3,854	7,820	16,693	23,517	6,275	4,258	2,943	3,754	7,804	4,606	1,768
25	2,394	2,812	6,608	40,793	14,220	6,334	4,386	2,990	2,924	7,986	6,185	1,579
26	1,881	2,790	6,637	36,126	4,482	5,817	3,794	2,851	2,969	6,227	6,322	1,596
27	2,499	2,772	7,253	32,729	5,729	5,459	4,215	2,571	2,474	5,388	5,683	1,497
28	2,765	2,558	10,886	30,217	5,117	5,309	3,781	2,410	3,149	2,644	6,169	2,317
29	2,531	2,794	5,945	30,517	4,867	4,200	3,728	2,416	3,148	3,214	8,424	2,063
30	2,473	.....	6,901	30,977	3,192	5,307	3,395	1,625	2,777	2,888	8,432	1,845
31	2,220	.....	5,006	.....	6,092	.....	3,831	2,531	.....	2,891	.....	1,787
Mean	4,304	2,830	13,140	27,400	17,050	5,520	5,330	3,150	3,410	3,664	9,059	2,750

Daily discharge, in second-feet, of Kennebec River at Waterville, Me.—Continued.

1897.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2,073	3,587	2,007	6,334	39,001	18,204	8,719	12,975	4,771	2,314	2,911	4,630
2	2,085	3,485	2,950	7,648	34,299	16,780	9,885	13,656	4,357	2,048	2,637	3,825
3	1,650	3,775	2,423	9,075	32,654	17,526	9,531	11,263	4,340	967	6,687	3,754
4	2,318	3,598	2,629	9,635	34,210	17,542	8,512	9,206	3,701	2,532	9,442	3,190
5	3,733	3,348	2,586	11,536	40,730	17,549	7,142	7,796	3,090	2,490	8,628	3,063
6	18,504	3,223	2,522	12,889	36,362	15,756	8,189	7,226	3,865	2,375	7,729	5,968
7	10,210	4,185	4,026	18,329	26,923	16,023	7,410	5,889	3,571	2,158	6,457	6,382
8	5,860	4,305	2,703	21,149	26,610	15,785	7,922	5,761	4,038	1,533	6,443	5,229
9	5,028	5,634	2,285	18,268	24,400	13,801	7,967	4,000	3,973	2,097	5,195	5,172
10	3,793	6,225	2,291	15,458	23,995	12,961	7,270	5,243	3,997	2,100	7,927	4,879
11	3,293	5,933	4,554	16,671	41,196	16,003	6,290	5,849	4,808	2,109	8,133	4,212
12	3,601	5,007	4,230	14,377	41,223	14,962	5,761	7,562	9,689	1,508	7,413	4,048
13	3,084	4,629	5,238	13,999	23,965	13,819	7,256	9,771	5,463	1,788	6,350	5,765
14	2,542	3,897	5,045	14,796	41,284	15,304	45,507	7,112	4,915	6,070	2,789	6,104
15	2,881	4,070	5,387	16,881	38,988	16,003	55,634	6,601	4,864	6,323	4,902	7,153
16	2,715	4,028	4,925	24,426	32,431	14,617	33,770	5,368	4,325	5,528	4,420	13,621
17	2,187	3,848	2,533	34,813	27,453	14,638	26,160	7,776	4,333	3,837	5,913	14,005
18	2,942	3,163	2,025	28,642	23,788	13,344	21,286	11,566	3,239	3,262	7,191	11,381
19	1,918	2,467	2,304	31,734	21,013	11,200	17,067	8,562	3,632	3,287	6,428	7,665
20	2,211	2,480	2,339	32,799	18,843	11,390	12,542	6,755	3,488	2,322	4,391	5,835
21	2,283	3,543	3,167	26,949	17,562	10,649	7,747	7,129	5,043	2,331	4,161	6,799
22	2,222	2,636	2,083	24,087	15,105	7,399	5,218	7,907	8,422	2,326	3,009	5,419
23	2,951	2,427	2,621	24,008	15,448	9,991	8,408	6,616	7,438	2,051	2,703	3,861
24	2,300	2,302	5,547	29,875	14,809	9,095	8,980	5,718	5,838	1,510	2,181	3,839
25	1,953	2,544	5,832	33,605	10,818	8,353	8,925	5,816	4,481	2,140	2,687	3,225
26	1,847	2,877	6,345	42,860	16,539	8,751	10,826	6,280	3,841	2,348	1,889	2,541
27	2,727	2,825	5,992	51,255	21,779	7,590	9,842	6,220	4,555	2,415	6,097	2,563
28	2,252	3,705	5,311	66,907	24,568	7,691	7,950	5,706	4,084	2,973	13,399	2,685
29	2,477	.....	4,994	58,745	26,000	8,023	6,734	5,382	2,915	2,008	6,883	3,001
30	4,024	.....	5,071	43,797	22,697	8,345	6,405	5,154	2,801	2,344	6,171	2,733
31	3,534	.....	5,513	.....	20,526	.....	11,707	4,364	.....	2,600	.....	2,699
Mean	3,587	3,705	3,790	25,385	26,943	12,970	13,115	7,298	4,595	2,635	5,702	5,330

1898.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2,475	2,539	4,170	20,385	36,048	14,341	4,385	3,790	2,477	2,691	6,382	3,752
2	2,284	2,955	4,188	16,556	39,372	13,776	4,343	2,707	2,489	2,862	5,182	3,740
3	2,222	2,687	5,648	13,871	38,301	10,900	3,440	2,887	2,453	2,180	4,691	3,667
4	2,715	3,090	5,163	12,143	37,358	8,791	3,490	2,833	1,437	1,831	4,115	1,747
5	2,771	2,775	2,997	10,830	37,730	9,846	4,343	2,809	2,510	1,865	3,467	3,336
6	3,431	3,068	4,094	10,150	37,569	10,301	4,272	3,712	2,392	2,119	3,231	3,227
7	1,807	3,475	5,070	7,080	31,580	9,189	4,477	3,252	3,093	1,570	3,880	3,221
8	4,826	2,994	5,033	6,563	29,880	9,038	4,203	4,374	3,073	1,269	3,675	3,262
9	5,434	3,744	4,767	7,472	28,753	12,541	5,464	4,218	3,018	1,150	4,133	2,995
10	4,492	3,154	4,623	10,457	25,636	14,318	1,745	4,017	3,042	961	3,351	2,635
11	3,025	3,829	5,329	15,209	22,059	12,086	4,111	3,048	3,050	1,585	5,332	1,792
12	3,286	3,317	6,752	19,848	21,899	11,322	4,484	3,413	3,057	1,731	5,856	3,268
13	3,240	3,680	8,397	44,854	24,042	11,003	4,267	2,927	2,505	1,585	4,896	2,235
14	3,287	3,912	9,880	47,141	34,332	10,777	3,776	1,130	1,913	1,288	3,332	1,873
15	4,909	4,026	11,534	50,381	32,988	12,514	4,327	3,443	1,480	1,299	3,405	1,888
16	3,717	4,042	12,816	49,415	27,500	11,295	3,994	2,499	1,560	3,665	3,264	1,883
17	3,891	3,764	12,215	47,112	24,756	10,584	3,611	2,590	1,530	6,031	3,490	2,469
18	3,453	3,221	11,918	47,321	23,440	9,478	3,896	2,491	1,570	5,055	3,698	1,723
19	3,460	3,267	12,484	44,700	23,153	9,196	3,938	2,622	1,607	4,454	5,018	2,315
20	3,505	2,885	13,218	39,327	20,592	11,129	3,747	2,526	1,876	3,264	8,798	2,447
21	3,893	3,172	14,580	36,671	19,088	10,855	3,835	913	2,223	2,872	8,935	2,560
22	4,614	3,764	17,177	33,789	18,570	9,950	5,038	3,425	1,851	2,690	8,046	2,274
23	2,542	2,133	16,615	30,792	17,073	8,334	3,871	2,866	1,888	6,036	7,184	2,778
24	2,321	3,437	15,987	34,352	15,277	9,483	3,418	3,425	1,916	6,318	6,007	3,018
25	2,866	4,352	17,812	52,119	15,993	8,864	3,747	2,849	3,689	4,924	7,811	2,489
26	2,032	3,933	17,029	45,520	15,589	7,508	3,879	4,432	5,443	4,288	7,923	2,471
27	3,136	3,653	16,560	38,083	15,639	5,267	3,385	4,218	4,788	6,514	10,037	2,761
28	2,905	4,387	18,928	37,354	14,611	4,326	4,189	3,940	3,581	15,319	3,672	2,464
29	2,727	.....	19,762	33,652	16,632	5,689	3,444	3,396	3,778	11,127	2,758	2,499
30	1,738	.....	17,711	31,767	16,962	6,715	3,204	3,555	3,247	9,229	3,723	2,067
31	2,607	.....	27,432	.....	16,298	.....	2,832	2,857	.....	7,672	.....	2,178
Mean	3,213	3,402	11,287	29,883	25,120	9,983	3,908	3,133	2,618	4,047	5,178	2,620

Daily discharge, in second-feet, of Kennebec River at Waterville, Me.—Continued.

1899.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2,529	2,458	3,382	6,411	41,756	13,044	6,115	4,809	1,623	.....	1,390	1,456
2	2,202	2,198	3,047	6,214	39,665	12,790	5,024	3,594	2,010	1,443	2,819	1,441
3	2,274	2,187	3,333	6,160	36,589	10,647	5,363	4,442	567	1,665	4,093	747
4	2,159	2,163	3,324	6,017	36,942	11,653	3,178	4,199	1,612	1,415	4,109	2,913
5	2,452	1,580	1,960	6,207	30,922	12,264	5,258	4,498	2,070	1,969	2,995	3,567
6	2,451	2,505	3,331	6,227	30,531	11,123	5,120	4,415	2,082	1,449	3,327	3,196
7	2,449	2,173	3,563	6,423	30,125	10,563	5,076	5,064	2,070	1,476	3,106	2,015
8	1,739	2,071	3,516	7,007	29,447	12,748	5,367	5,195	.....	.....	2,637	2,070
9	2,757	2,057	3,502	7,541	26,888	12,517	3,936	4,388	2,352	1,215	2,338	1,737
10	2,513	2,152	3,428	9,001	24,803	12,506	5,142	4,128	246	940	2,119	.....
11	2,400	2,141	3,357	9,650	22,132	10,738	5,123	4,101	2,635	774	1,698	1,393
12	2,386	2,244	2,302	9,405	20,229	10,278	4,866	3,954	2,067	1,784	.....	1,160
13	2,404	2,348	3,353	11,181	18,697	6,039	5,100	2,699	2,340	1,968	1,488	2,022
14	2,436	1,964	3,423	19,700	19,643	7,030	5,950	3,964	2,370	1,391	1,970	5,223
15	1,678	1,844	3,624	23,106	14,886	6,739	5,078	3,538	2,257	492	2,017	4,410
16	2,731	2,392	3,773	38,826	15,099	7,557	4,043	3,213	1,261	1,378	2,053	4,621
17	2,439	2,434	3,501	30,532	17,307	5,913	4,866	3,007	1,298	1,667	1,823	1,861
18	2,631	2,727	3,253	30,312	15,073	6,807	5,232	3,321	1,416	1,366	1,739	2,695
19	2,434	2,198	1,960	37,096	15,071	7,290	4,948	2,643	2,005	1,096	.....	2,027
20	2,629	2,915	3,320	41,565	15,684	6,483	4,880	1,242	2,362	1,377	1,718	2,611
21	2,440	2,734	3,080	34,540	16,262	7,101	5,499	2,748	2,006	1,120	2,317	1,878
22	2,094	2,744	2,778	30,286	18,287	7,317	6,367	3,377	2,351	.....	1,748	2,340
23	2,709	2,451	2,711	39,550	17,271	7,319	5,688	2,956	2,348	1,408	2,085	2,617
24	2,154	2,745	2,837	45,724	15,900	7,516	6,509	2,534	1,073	1,334	2,035	2,068
25	2,435	2,929	2,770	41,739	15,925	5,673	5,837	2,180	2,031	1,104	2,028	.....
26	2,450	1,420	2,030	43,139	11,480	7,301	5,916	2,158	1,761	995	.....	.....
27	2,454	3,039	2,786	45,795	12,567	7,315	5,502	1,089	1,466	1,149	1,413	2,323
28	2,434	3,362	2,740	39,943	12,303	6,880	5,649	2,288	2,046	1,121	1,743	2,330
29	1,245	.....	2,998	41,584	13,064	7,038	4,170	2,203	1,951	406	1,744	1,821
30	2,513	.....	3,962	39,300	13,035	6,445	2,500	2,065	2,091	1,104	.....	1,474
31	2,453	.....	6,820	.....	12,823	.....	4,087	2,354	.....	1,086	.....	.....
Mean	2,357	2,363	3,218	24,006	21,303	8,821	5,077	3,302	1,854	1,274	2,252	2,741

1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1,463	7,117	15,468	8,792	22,830	12,115	4,849	4,910	4,238	2,859	2,307	6,540
2	1,565	3,696	13,353	8,381	27,905	12,782	8,232	5,149	1,635	3,337	2,357	4,394
3	1,604	3,628	9,656	9,338	28,823	15,730	7,520	5,525	3,191	3,134	2,293	6,146
4	1,653	.....	11,445	14,047	52,268	25,091	2,763	5,601	3,180	2,876	1,502	5,968
5	1,193	3,166	6,544	15,927	48,843	19,591	6,715	4,431	2,905	2,565	1,660	4,640
6	1,452	3,159	6,240	15,544	39,585	16,103	6,255	5,357	2,913	2,168	2,260	4,583
7	1,304	3,188	9,323	19,353	34,551	14,088	6,271	4,708	2,865	859	1,604	4,506
8	2,324	3,303	4,913	27,072	28,889	12,792	4,799	4,597	2,908	3,457	1,630	4,701
9	2,060	2,925	4,947	24,219	23,561	10,930	6,465	4,573	2,276	3,715	3,819	3,548
10	1,998	3,114	4,927	19,765	28,628	10,495	6,501	4,758	2,930	3,715	17,580	4,498
11	1,751	1,615	4,373	17,053	25,277	10,083	5,767	4,462	2,871	4,051	11,521	2,978
12	1,711	2,933	4,950	20,560	22,411	10,148	4,984	2,627	2,865	4,106	13,301	3,504
13	1,009	12,148	4,932	25,463	20,804	9,661	12,281	4,651	2,560	4,003	10,314	3,851
14	696	15,696	4,799	27,373	18,378	10,168	9,601	4,716	2,851	.....	8,564	4,078
15	1,712	21,761	5,051	26,429	22,307	7,707	6,262	4,450	2,826	2,590	5,839	4,101
16	1,996	19,766	10,516	31,224	29,793	9,141	7,018	4,750	2,426	3,993	4,877	3,080
17	1,755	15,073	7,479	32,034	29,945	7,256	5,112	4,834	3,130	3,993	3,706	3,958
18	1,748	11,998	12,670	35,155	31,845	7,808	6,017	4,624	3,147	4,190	6,533	4,068
19	2,064	5,871	20,538	42,557	40,265	7,308	5,652	3,075	2,776	3,989	5,079	3,505
20	1,792	7,090	12,562	60,541	48,460	5,866	6,057	4,547	2,602	3,720	5,215	3,809
21	656	6,978	12,448	62,291	44,162	6,402	5,678	4,072	3,044	2,392	8,107	3,799
22	2,060	6,123	12,412	55,363	35,060	6,651	4,386	3,203	2,776	3,164	6,360	4,109
23	4,045	5,308	11,361	51,180	25,403	6,613	5,253	4,029	.....	3,185	12,471	1,895
24	3,748	4,117	10,742	44,064	23,333	5,015	4,923	3,649	3,137	2,621	8,620	3,880
25	3,697	18,833	9,792	38,913	21,682	6,669	4,737	.....	2,887	2,902	7,886	3,196
26	3,684	13,387	9,460	33,353	18,907	5,066	5,403	1,016	2,563	2,624	7,000	4,311
27	3,609	23,971	8,925	27,800	17,467	5,803	4,857	3,169	2,575	2,373	7,320	4,498
28	3,007	18,375	8,604	23,905	15,469	7,679	4,872	3,501	2,568	1,520	9,693	4,299
29	6,851	.....	8,391	21,793	19,171	7,189	2,344	3,629	3,169	2,902	5,214	4,035
30	1,311	.....	8,410	14,688	16,301	9,043	4,231	3,147	2,197	2,623	6,660	2,[illegible]8
31	5,399	.....	8,498	.....	14,113	.....	3,725	3,454	.....	2,338	.....	4,050
Mean	2,384	9,050	9,153	28,473	28,272	10,033	5,791	4,173	2,807	3,065	6,376	4,096

Estimated monthly discharge of Kennebec River at Waterville, Me.

[Drainage area, 4,410 square miles.]

Month.	Discharge in second-feet.			Run-off.		Rainfall, in inches.
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.	
1893.						
January 12 to 31	5,000	1,900	2,650	0.60	0.69	1.62
February	3,000	2,100	2,350	0.53	0.55	2.77
March	11,300	2,300	4,180	0.95	1.09	2.49
April	19,800	3,600	11,660	2.64	2.95	2.13
May	83,500	13,600	30,520	6.92	7.98	3.42
June	23,500	11,000	15,290	3.47	3.87	0.99
July	11,230	2,240	5,770	1.31	1.51	2.27
August	2,430	1,940	2,270	0.51	0.59	2.90
September	2,680	1,710	2,040	0.46	0.52	2.12
October	4,000	1,440	2,330	0.53	0.61	4.89
November	3,980	1,980	2,230	0.51	0.56	0.86
December	2,780	1,440	1,580	0.36	0.41	2.36
The year	83,500	1,440	6,906	1.57	21.33	28.82
1894.						
January	1,910	1,470	1,640	0.37	0.43	2.43
February	1,910	1,740	1,780	0.40	0.42	1.03
March	6,660	1,740	4,020	0.91	1.05	0.86
April	35,280	4,370	14,680	3.33	3.71	0.72
May	15,650	6,100	9,570	2.17	2.50	3.78
June	12,930	3,710	7,790	1.77	1.97	2.97
July	10,020	3,345	5,720	1.30	1.50	2.56
August	3,305	2,294	2,970	0.67	0.78	3.50
September	12,102	467	2,740	0.62	0.69	3.82
October	9,036	1,655	3,750	0.85	0.98	2.41
November	10,512	1,444	3,760	0.85	0.95	2.02
December	2,600	904	1,930	0.44	0.50	1.82
The year	35,280	467	5,029	1.12	15.48	27.92

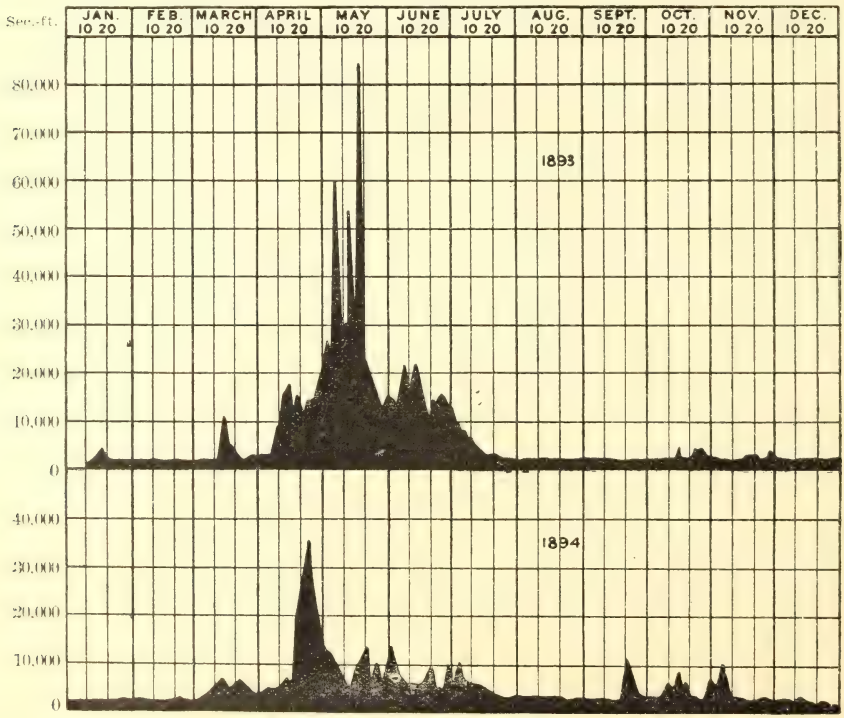


FIG. 1.—Discharge of Kennebec River at Waterville, Me., 1893 and 1894.

Estimated monthly discharge of Kennebec River at Waterville, Me.—Continued.

Month.	Discharge in second-feet.			Run-off.		Rainfall, in inches.
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.	
1895.						
January	2,509	1,135	2,040	0.46	0.53	2.23
February	2,444	579	1,800	0.41	0.43	0.34
March	2,769	1,252	2,000	0.45	0.52	1.58
April	86,201	2,176	23,930	5.43	6.05	3.50
May	16,175	4,868	9,580	2.17	2.50	1.83
June	9,818	4,497	6,430	1.46	1.63	1.96
July	5,042	2,096	3,520	0.80	0.92	3.08
August	5,089	857	2,690	0.61	0.70	2.59
September	2,867	1,104	1,780	0.40	0.45	1.11
October	1,587	1,081	1,250	0.28	0.33	1.58
November	15,900	1,081	5,610	1.27	1.42	5.47
December	26,673	1,747	6,030	1.37	1.58	3.77
The year	86,201	579	5,555	1.26	17.06	29.04

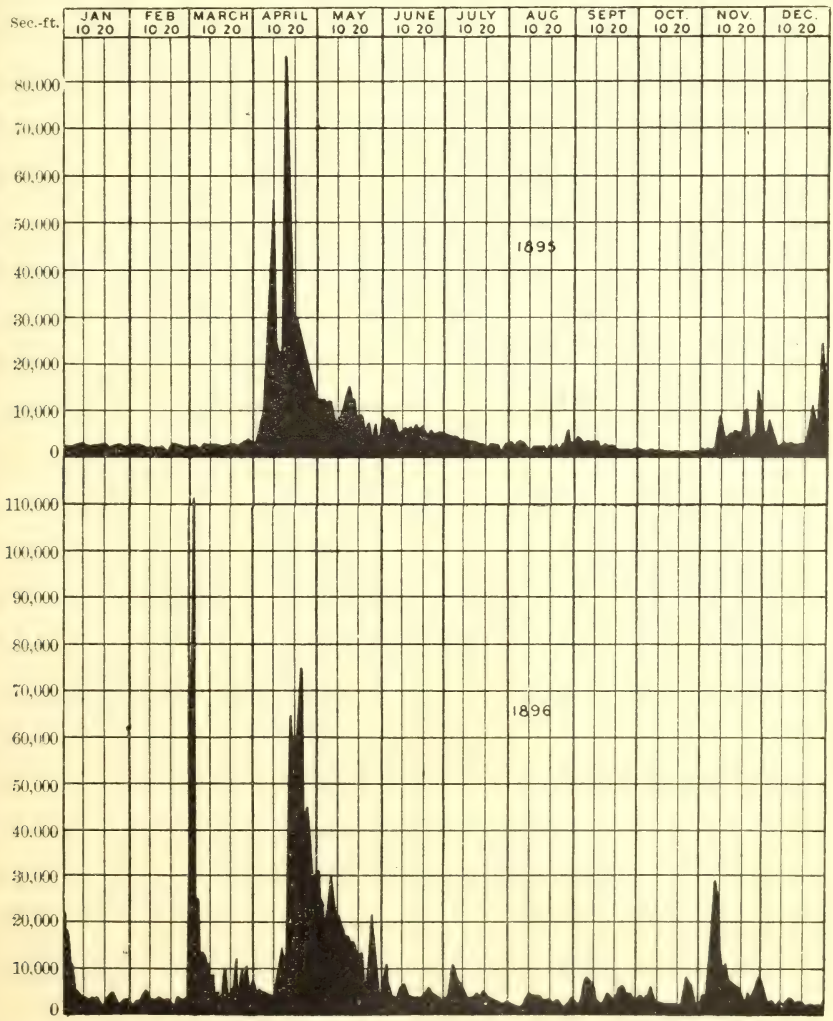


FIG. 2.—Discharge of Kennebec River at Waterville, Me., 1895 and 1896.

Estimated monthly discharge of Kennebec River at Waterville, Me.—Continued.

Month.	Discharge in second-feet.			Run-off.		Rainfall, in inches.
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.	
1896.						
January	21,881	1,568	4,304	0.98	1.13	0.31
February	4,634	1,292	2,830	0.64	0.69	2.95
March	111,246	3,239	13,140	2.98	3.44	5.62
April	74,469	4,998	27,400	6.21	6.93	1.28
May	30,879	3,192	17,050	3.87	4.46	2.33
June	11,004	3,855	5,520	1.25	1.40	1.91
July	11,678	3,335	5,330	1.21	1.39	3.21
August	4,737	1,625	3,150	0.71	0.82	3.83
September	7,978	1,733	3,410	0.77	0.86	5.10
October	8,956	2,016	3,664	0.83	0.96	2.00
November	29,865	3,435	9,059	2.07	2.31	2.35
December	8,049	1,489	2,750	0.62	0.72	1.17
The year	111,246	1,292	8,134	1.84	25.11	32.06
1897.						
January	18,504	1,650	3,587	0.82	0.94	3.31
February	6,225	2,302	3,705	0.84	0.88	1.00
March	6,345	2,007	3,970	0.86	0.99	2.63
April	66,907	6,334	25,385	5.75	6.41	2.40
May	41,284	10,818	26,942	6.11	7.05	4.47
June	18,204	7,399	12,970	2.95	3.28	3.39
July	55,634	5,218	13,115	2.98	3.44	3.52
August	13,656	4,000	7,298	1.65	1.90	2.82
September	9,689	2,801	4,595	1.08	1.20	2.54
October	6,323	967	2,635	0.60	0.69	0.53
November	13,399	1,889	5,702	1.29	1.44	3.98
December	14,005	2,541	5,331	1.21	1.39	3.06
The year	66,907	967	9,588	2.18	29.61	33.65
1898.						
January	5,434	1,738	3,213	0.73	0.84	5.07
February	4,387	2,133	3,402	0.77	0.80	6.48
March	27,432	12,997	11,287	2.56	2.95	1.45
April	52,119	6,563	29,833	6.76	7.54	2.31
May	39,372	14,611	25,120	5.70	6.57	1.55
June	14,341	4,326	9,983	2.26	2.52	3.32
July	5,464	1,745	3,908	0.89	1.02	1.13
August	4,432	913	3,133	0.71	0.82	3.71

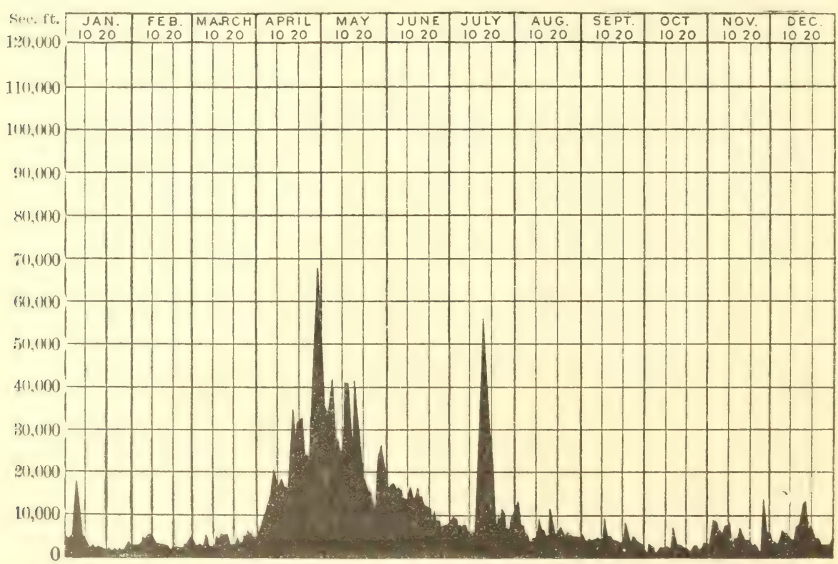


FIG. 3.—Discharge of Kennebec River at Waterville, Me., 1897.

Estimated monthly discharge of Kennebec River at Waterville, Me.—Continued.

Month.	Discharge in second-feet.			Run-off.		
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.	Rainfall, in inches.
1898.						
September	5,443	1,437	2,618	0.59	0.65	2.37
October	15,319	961	4,047	0.92	1.06	4.33
November	10,037	2,758	5,178	1.17	1.31	3.71
December	3,752	1,723	2,620	0.59	0.68	1.42
The year	52,119	913	8,695	1.97	26.76	36.85

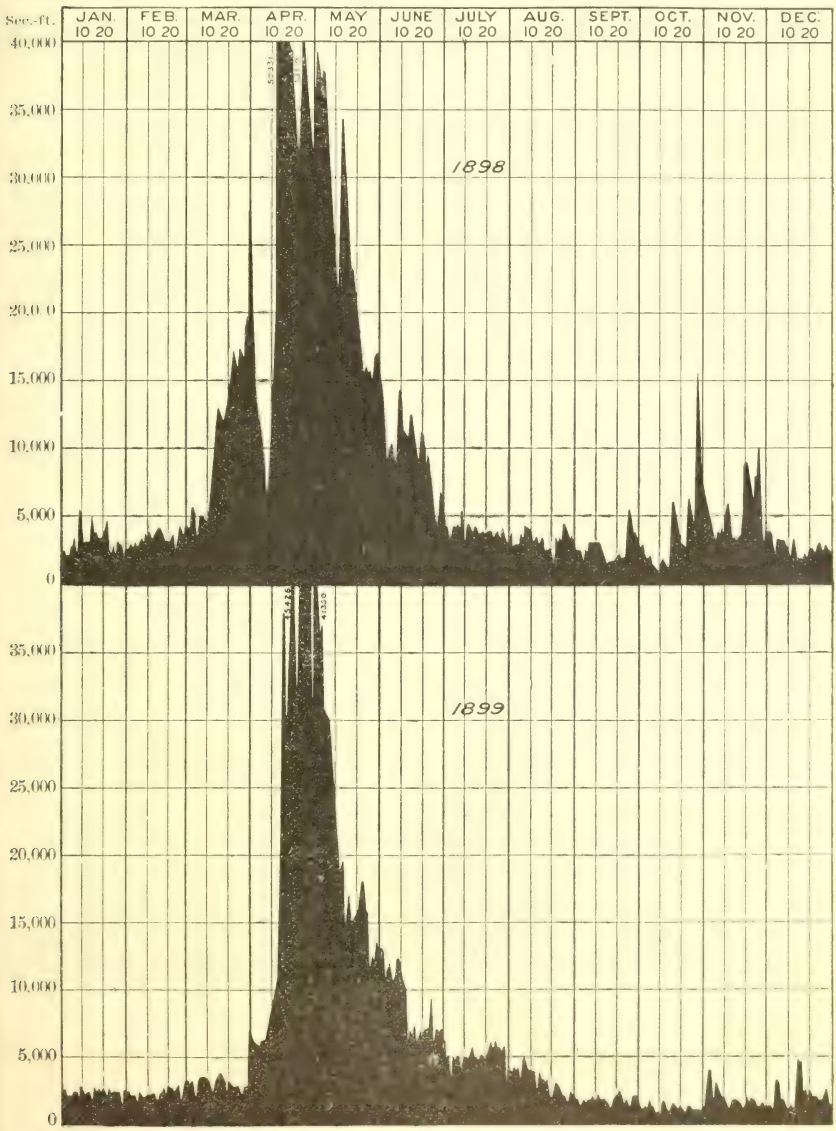


FIG. 4.—Discharge of Kennebec River at Waterville, Me., 1898 and 1899.

Estimated monthly discharge of Kennebec River at Waterville, Me.—Continued.

Month.	Discharge in second-feet.			Run-off.		Rainfall, in inches.
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.	
1899.						
January	2,757	1,245	2,357	0.53	0.61	2.76
February	3,362	1,420	2,364	0.54	0.56	2.73
March	6,820	1,960	3,218	0.73	0.84	3.66
April	45,422	5,945	23,429	5.31	5.93	1.05
May	41,348	11,380	21.228	4.81	5.54	2.05
June	13,292	5,593	8,807	2.00	2.23	1.39
July	6,386	2,400	5,036	1.14	1.31	5.13
August	4,968	1,620	3,217	0.73	0.84	0.46
September	2,565	1,200	1,906	0.43	0.48	3.58
October	1,823	561	1,224	0.28	0.32	1.11
November	4,025	1,100	2,021	0.46	0.52	2.32
December	4,898	900	2,254	0.51	0.59	1.93
The year	45,422	561	6,422	1.46	19.77	28.17
1900.						
January	6,851	656	2,384	0.54	0.62	5.89
February	23,971	1,615	9,050	2.05	2.14	7.00
March	20,538	4,373	9,153	2.08	2.40	4.75
April	62,291	8,381	28,473	6.46	7.21	1.63
May	52,268	14,113	28,272	6.41	7.39	5.18
June	25,091	5,015	10,033	2.27	2.53	4.08
July	12,281	2,344	5,791	1.31	1.51	3.40
August	5,601	1,016	4,173	0.95	1.09	1.76
September	4,238	1,635	2,807	0.64	0.71	2.55
October	4,190	859	3,065	0.70	0.81	4.05
November	17,580	1,502	6,376	1.45	1.62	4.55
December	6,540	1,895	4,096	0.93	1.07	2.19
The year	62,291	656	9,473	2.15	29.10	47.03

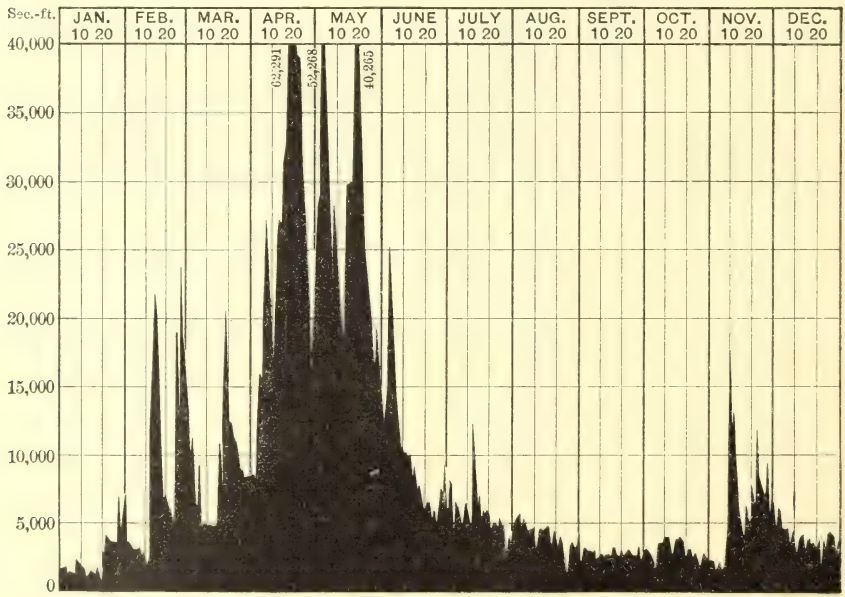


FIG. 5.—Discharge of Kennebec River at Waterville, Me., 1900.

The following table gives the monthly and yearly run-off of the Kennebec Basin for the years 1893 to 1900, inclusive:

Run-off, in second-feet per square mile, of Kennebec River at Waterville, Me.

[Drainage area, 4,410 square miles.]

	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.	Average.
January	0.60	0.37	0.46	0.98	0.82	0.73	0.53	0.54	0.63
February	0.53	0.40	0.41	0.64	0.84	0.77	0.54	2.05	0.77
March	0.95	0.91	0.45	2.98	0.86	2.56	0.73	2.08	1.44
April	2.64	3.33	5.43	6.21	5.75	6.76	5.31	6.46	5.24
May	6.92	2.17	2.17	3.87	6.11	5.70	4.81	6.41	4.77
June	3.47	1.77	1.46	1.25	2.95	2.26	2.00	2.27	2.18
July	1.31	1.30	0.80	1.21	2.98	0.89	1.14	1.31	1.37
August	0.51	0.67	0.61	0.71	1.65	0.71	0.73	0.95	0.82
September	0.46	0.62	0.40	0.77	1.08	0.59	0.43	0.64	0.62
October	0.53	0.85	0.28	0.83	0.60	0.92	0.28	0.70	0.62
November	0.51	0.85	1.27	2.07	1.29	1.17	0.46	1.45	1.13
December	0.36	0.44	1.37	0.62	1.21	0.59	0.51	0.93	0.75
The year	1.57	1.12	1.26	1.84	2.18	1.97	1.46	2.15	1.70

In the following table is given a comparison between the precipitation at Fairfield, Me., and the run-off of the Kennebec Basin. Fairfield is near the southern end of the basin, and it is likely that the rainfall may increase somewhat in the northern and more elevated portions of the area. The Geological Survey has recently established gages in the northern part of the basin, but the records are not of sufficient length for use in these comparisons.

Ratio of run-off to rainfall in basin of Kennebec River.

	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.	Average.
Precipitation, inches	28.82	27.92	29.04	32.06	33.65	36.85	28.17	47.03	32.94
Run-off, inches	21.33	15.48	17.06	25.11	29.61	26.76	19.77	29.10	23.03
Ratio	0.74	0.55	0.59	0.78	0.88	0.73	0.70	0.62	0.70

TRIBUTARIES OF MOOSEHEAD LAKE AND KENNEBEC RIVER.

ROACH RIVER.

Roach River receives its headwaters from the slopes of Boardman and White Cap Mountain, flows through a series of ponds, and finally enters Spencer Bay, an arm of Moosehead Lake. This stream and Moose River are the upper feeders of Moosehead Lake. In 1901 a gaging station was established by the Geological Survey at the foot of Roach Pond, where records of river height will be read daily by a local observer and meter measurements made often enough to construct a rating curve.

MOOSE RIVER.

Moose River, the largest feeder of Moosehead Lake, with a drainage area of 660 square miles, has a number of large lakes in its basin,

which in most parts of the country would be considered excellent storage reservoirs, but when compared with Moosehead Lake are of small capacity. It is possible, however, that when the flow of the Kennebec is more carefully regulated it will be considered advisable to utilize these lakes as secondary storage basins. At present there are several dams on the river, for the purpose of holding back water for driving logs.

TOMHEGAN AND SOCATEAN RIVERS.

These are two small streams feeding Moosehead Lake. They have a number of small lakes in their watersheds and considerable fall throughout their courses.

DEAD RIVER.

South of Moosehead Lake the Kennebec receives a number of small tributaries, by far the most important being the west outlet of that lake. About 23 miles south of the lake Dead River adds its waters to the Kennebec. The drainage basin of this stream has an area of 1,000 square miles, for the most part a wild forested area. The river has at intervals falls of considerable heights, which would be valuable for water power if transportation were available. The storage capacity on this stream is limited. Hurricane Falls, Long Falls, and Grand Falls could, however, be economically utilized.

During the summer of 1901 the United States Geological Survey established a gaging station on the river, at The Forks.

SANDY RIVER.

Sandy River, a large tributary from the west, rises in a hilly country near the Rangeley Lakes, and has an aggregate fall of about 1,600 feet. Unlike most of the rivers of this region it has no tributary lake of large size, and therefore lacks that regulating influence. The drainage area is about 650 square miles, but the flow is small and the fluctuations are quite marked. The Sandy River Railroad follows the river throughout most of its course, furnishing good transportation, but only small developments of water power have been made, viz, at New Sharon and Farmington.

CARRABASSETT RIVER.

This river enters the Kennebec from the west, at North Anson. It has considerable fall, which has been used to some extent for power development. There are sites for further development, perhaps the best being in the town of North Anson. In Pl. IX, *A* is shown an undeveloped fall near the mouth of the stream. Gagings of the river are now regularly made by the United States Geological Survey.

A. FALLS ON CARRABASSETT RIVER, NORTH ANSON.

B. FALLS ON MESSALONSKEE RIVER AT OAKLAND.

SEBASTICOOK RIVER.

Sebasticook River, with a drainage area of 1,060 square miles, enters the Kennebec from the east, opposite Waterville. In the 45 miles from Moose Pond to the mouth there is a fall of 170 feet. The stream is followed closely by railroads and possesses a number of good water powers, perhaps the most important being that of the Kennebec Fiber Company, about 5 miles from the mouth, which utilizes 1,400 horsepower under an average head of 26 feet.

MESSALONSKEE RIVER.

Messalonskee River drains 205 square miles and discharges into the Kennebec from the west, at Waterville. It is fed from extensive lakes, the aggregate surface area of which is between 25 and 30 square miles. These render its flow very constant and give it considerable value for power. The fall is stated to be 164 feet in the 5 or 6 miles from the lowest lake to the mouth. Near the mouth the Union Gas and Electric Company develops 800 horsepower over a 35-foot dam, the power being transformed into electricity for both power and lighting. Above this point power is utilized to the extent of 250 horsepower for the Waterville pumping station and for several molding and planing mills. Farther upstream, in Oakland, there are several excellent powers, with falls of 14, 40, 15, and 12 feet, which are partially utilized. One of these power sites is shown is Pl. IX, *B*.

COBBOSSEECONTEE RIVER.

Cobbosseecontee River drains a group of lakes lying from 5 to 15 miles westerly from Augusta, and empties into the Kennebec 6 miles below that city at Gardiner, its drainage area amounting to about 230 square miles. From the ordinary surface of Lake Maranacook, one of the upper lakes, to mean tide at the mouth of the river the fall is 206 feet, and in the lower three-fourths of a mile it is said to be 136 feet. From above the uppermost of the 8 dams controlled by the Gardiner Water Power Company, which are in the latter three-fourths of a mile, the municipal water supply for Gardiner is drawn and pumped by water power. Record is kept of the water pumped and of the water that passes the dam through a waste gate. The sum of these quantities represents the yield of the drainage area at the upper dam, records of which have been kept by the Gardiner Water Power Company for a series of years, and have been furnished to the Survey by their engineer, Mr. A. H. Twombly. These records are presented in the accompanying tables. On Sundays and on legal holidays the gates are closed and no water is permitted to run unless the lakes are full. This is a most remarkable example of the regularity of flow that can be obtained with proper storage.

Daily discharge, in second-feet, of Cobbosseecontee River at the upper dam near Augusta, Me.

[Drainage area, 230 square miles.]

1890.

Day.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	300	290	290	290	393	300
2	.....	300	290	290	290	379	300
3	.....	300	.....	290	290	379	300
4	.....	.....	290	290	290	379	300
5	.....	306	290	290	.....	368	300
6	.....	326	290	290	290	357	300
7	.....	356	290	.....	290	347	.....
8	.....	374	290	290	300	347	300
9	.....	374	290	290	300	333	300
10	.....	340	.....	290	300	333	300
11	.....	314	290	290	300	326	300
12	.....	306	290	290	.....	300	300
13	.....	156	290	290	300	300	300
14	.....	300	290	.....	300	300	.....
15	.....	300	290	290	300	300	300
16	340	300	290	290	300	.....	300
17	356	300	.....	290	300	300	300
18	356	.....	290	290	300	379	300
19	356	.....	290	290	.....	445	300
20	340	290	290	290	300	431	300
21	326	290	290	290	300	418	.....
22	.....	290	290	290	300	405	300
23	300	290	290	290	300	393	300
24	300	290	34	290	337	379	300
25	306	290	290	290	337	368	.....
26	314	290	290	290	337	357	290
27	314	.....	280	290	345	347	290
28	306	290	290	.....	345	337	.....
29	.....	290	290	290	345	337	290
30	300	290	290	290	379	300	290
31	.....	290	.....	.....	393	.....	290
Mean	324	302	290	290	313	356	298

1891.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	290	850	839	2,169	300	300	300	290	285	260	(a)	(a)
2	290	780	774	2,114	300	300	300	.....	285	260	(a)	(a)
3	290	713	713	2,059	.....	300	300	285	280	260	(a)	(a)
4	.....	713	653	2,059	300	300	.....	285	280	.....	(a)	(a)
5	290	682	594	2,059	300	300	.....	285	280	260	(a)	(a)
6	290	620	567	1,940	300	300	300	285	.....	250	(a)	220
7	290	590	540	1,836	300	.....	300	290	280	250	(a)	220
8	290	.....	540	1,782	300	300	300	290	280	250	(a)	220
9	290	373	515	1,598	300	300	300	.....	280	250	(a)	220
10	290	435	540	1,567	.....	300	300	285	280	250	(a)	(a)
11	.....	458	743	1,495	300	300	300	285	280	.....	(a)	(a)
12	300	458	807	1,514	300	300	.....	285	270	250	(a)	(a)
13	300	458	807	1,514	300	300	290	285	.....	250	(a)	(b)
14	300	548	1,801	1,365	300	.....	290	285	270	250	(a)	(a)
15	300	529	1,753	1,223	300	300	290	285	270	250	(a)	(a)
16	300	590	1,573	1,270	300	300	290	.....	270	250	(a)	(a)
17	300	602	1,364	1,318	.....	300	290	285	270	250	(a)	(a)
18	300	574	1,286	1,318	300	300	290	285	270	.....	(a)	(a)
19	300	516	1,241	1,318	300	300	.....	285	270	220	(a)	(a)
20	300	516	1,204	1,318	306	300	290	285	.....	220	(a)	(b)
21	300	483	1,167	1,273	314	.....	290	285	270	220	(a)	(a)
22	300	483	1,531	1,050	316	300	290	285	270	220	(a)	(a)
23	503	363	2,199	1,013	300	300	290	.....	270	220	(a)	(a)
24	1,120	363	2,365	300	.....	300	290	285	260	220	(a)	220
25	1,100	393	2,365	300	300	300	290	285	260	.....	(a)	(b)
26	1,063	620	2,585	314	300	300	.....	285	260	220	(a)	(b)
27	1,063	942	2,531	306	300	300	290	285	.....	(a)	(a)	(b)
28	1,063	907	2,344	306	300	.....	290	285	260	(a)	(a)	220
29	1,063	.....	2,344	300	300	300	290	285	260	(a)	(a)	220
30	1,079	.....	2,344	300	300	300	290	.....	260	(a)	(a)	220
31	1,001	.....	2,295	.....	.....	.....	290	285	.....	(a)	.....	220
Mean	516	576	1,385	1,277	301	300	293	286	272	242	.....	.....

[a] Water so low only gage record kept.
[b] Water shut back Sundays and holidays.

Daily discharge, in second-feet, of Cobbosseecontee River, etc.—Continued.

1892.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	220	270	280	280	.....	280	280	280	280	280	280	280
2	220	270	280	280	280	280	280	280	280	.....	280	280
3	.....	270	280	.....	280	280	.....	280	280	280	280	280
4	220	280	280	280	280	280	.....	280	.....	280	280	.....
5	250	280	280	280	280	.....	280	280	280	280	280	280
6	250	280	.....	294	280	280	280	280	280	280	.....	280
7	250	.....	280	294	280	280	280	.....	280	280	280	280
8	250	280	280	294	.....	280	280	280	280	280	280	280
9	250	280	280	286	280	280	280	280	280	.....	280	280
10	.....	280	280	.....	280	280	280	280	280	280	280	280
11	250	280	280	306	280	280	(a)	280	.....	280	280	.....
12	250	280	280	294	280	.....	(a)	280	280	280	280	280
13	250	280	.....	280	280	280	(a)	280	280	280	.....	280
14	250	.....	280	280	280	280	(a)	.....	280	280	280	280
15	270	280	280	280	.....	280	(a)	280	280	280	280	280
16	270	280	280	280	280	280	(a)	280	280	.....	280	280
17	.....	280	280	.....	280	280	(a)	280	280	280	280	280
18	270	280	280	280	280	.....	280	280	.....	280	280	.....
19	270	280	280	280	280	.....	280	280	280	280	280	280
20	276	280	.....	280	280	280	280	280	280	280	.....	280
21	276	.....	280	280	280	280	280	.....	280	280	280	280
22	270	280	280	280	280	280	280	280	280	280	280	280
23	270	280	280	280	280	280	280	280	280	.....	280	280
24	.....	280	280	.....	280	280	.....	280	280	280	.....	280
25	270	280	280	280	280	280	280	280	.....	280	280	.....
26	270	280	280	280	280	.....	280	280	280	280	280	280
27	270	280	.....	280	280	280	280	280	280	280	.....	280
28	270	.....	280	280	280	280	280	.....	280	280	280	280
29	270	280	280	280	280	280	280	280	280	280	280	280
30	270	.....	280	280	280	280	280	280	280	.....	280	280
31	.....	.....	280	.....	280	.....	.....	280	.....	280	.....	280
Mean	258	279	280	283	280	280	280	280	280	280	280	280

a Water shut back.

1893.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	280	280	535	435	300	280	280	(a)	.....	250	220
2	280	280	280	314	458	300	.....	280	(a)	250	250	220
3	280	280	280	300	509	300	280	280	(a)	250	250	.....
4	280	280	280	300	596	.....	.....	280	270	250	250	220
5	280	280	.....	300	1,079	300	280	280	(a)	220	.....	220
6	280	280	280	300	1,295	300	280	.....	(a)	(a)	220	220
7	280	280	280	300	1,179	300	280	280	(a)	(a)	220	220
8	.....	280	280	300	985	300	280	270	(a)	(a)	220	220
9	280	280	280	.....	713	300	.....	270	270	220	220	220
10	280	280	280	300	620	300	280	270	.....	220	220	.....
11	280	280	280	314	590	.....	280	270	270	220	220	220
12	280	.....	.....	481	562	280	280	270	270	220	.....	220
13	280	280	280	682	562	280	280	.....	270	(a)	220	220
14	280	280	509	650	887	280	280	270	270	(a)	220	220
15	.....	280	620	650	1,262	280	280	270	(a)	(a)	220	220
16	280	280	620	1,040	1,354	280	.....	270	(a)	220	220	220
17	280	280	535	1,079	1,552	280	280	270	(a)	220	220	.....
18	280	280	509	1,001	2,680	.....	280	270	270	220	220	220
19	280	.....	458	962	2,481	280	280	270	270	(a)	.....	220
20	280	280	435	925	2,002	280	280	.....	270	(a)	220	220
21	280	280	393	887	1,900	280	280	270	270	(a)	220	220
22	.....	280	393	962	1,752	280	280	270	(a)	(a)	220	220
23	280	280	356	962	1,660	280	.....	270	(a)	(a)	220	220
24	280	280	356	925	1,428	280	280	270	(a)	(a)	220	.....
25	280	280	356	780	1,052	.....	280	270	250	250	220	.....
26	280	.....	458	713	562	280	280	270	250	250	.....	220
27	280	280	590	620	326	280	280	.....	250	250	220	220
28	280	280	620	650	326	280	280	270	250	250	220	220
29	.....	.....	562	620	326	280	280	270	250	.....	220	220
30	280	.....	780	393	326	280	.....	270	250	250	.....	220
31	280	.....	620	.....	307	.....	280	270	.....	250	.....	.....
Mean	280	280	422	629	1,025	287	280	272	263	236	225	220

a Water shut back.

Daily discharge, in second-feet, of Cobbosseecontee River, etc.—Continued.

1894.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	220	220	220	.....	300	925	.....	280	280	270	250	250
2	220	220	220	314	300	889	280	280	.....	250	250	.....
3	220	220	220	314	300	674	280	280	.....	250	250	250
4	220	.....	.....	306	280	326	.....	280	280	250	.....	250
5	220	220	220	306	280	326	280	.....	280	250	250	250
6	220	220	220	306	.....	326	280	280	280	250	250	250
7	.....	220	220	306	280	326	280	280	270	.....	250	250
8	220	220	220	26	280	326	.....	280	270	250	250	250
9	220	220	220	326	280	326	280	280	.....	250	250	.....
10	220	220	220	314	280	200	280	280	270	250	250	250
11	220	.....	.....	314	280	326	280	280	270	250	.....	250
12	220	220	276	314	280	314	280	.....	270	250	250	250
13	220	220	483	314	.....	300	280	280	270	250	250	250
14	.....	220	483	314	280	300	280	280	270	.....	250	250
15	220	220	426	.....	280	280	.....	280	270	250	250	250
16	220	220	426	430	280	280	280	280	.....	250	250	.....
17	220	220	410	430	280	.....	280	280	270	250	250	250
18	220	.....	405	430	280	280	280	280	270	250	.....	250
19	220	220	405	314	280	280	280	.....	270	250	250	250
20	220	220	630	314	.....	280	280	280	270	250	250	250
21	.....	220	900	314	280	280	280	280	270	.....	250	250
22	220	220	887	26	280	280	.....	280	270	250	250	250
23	220	220	692	326	280	280	280	280	.....	250	250	.....
24	220	220	306	314	280	.....	280	280	270	250	250	250
25	220	.....	14	314	280	280	280	280	270	250	.....	.....
26	220	220	314	306	336	280	280	.....	270	250	250	250
27	220	220	314	300	523	280	280	280	270	250	250	250
28	.....	220	314	300	499	280	280	280	270	.....	250	250
29	220	.....	300	.....	370	280	.....	280	270	250	.....	250
30	220	.....	300	300	523	280	280	280	.....	250	250	.....
31	220	.....	300	.....	862	.....	280	280	.....	250	.....	250
Mean	220	220	364	303	333	350	280	280	272	251	250	250

1895.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	250	250	.....	250	385	280	280	280	.....	220	(a)	.....
2	250	250	.....	250	318	.....	280	280	270	220	(a)	220
3	250	.....	.....	250	300	280	280	280	270	220	.....	220
4	250	220	220	250	290	280	.....	.....	270	(a)	(a)	220
5	250	220	220	250	.....	280	280	280	270	(a)	(a)	220
6	.....	220	220	250	280	280	280	280	270	.....	(a)	220
7	250	220	220	14	280	280	.....	280	270	220	(a)	220
8	250	220	.....	343	280	280	280	280	.....	(a)	(a)	.....
9	250	220	220	733	280	.....	280	280	270	(a)	(a)	220
10	250	.....	.....	2,619	280	280	280	280	250	(a)	.....	220
11	250	220	220	1,301	280	280	280	.....	250	(a)	(a)	220
12	250	220	220	1,384	.....	280	280	270	250	(a)	(a)	220
13	.....	220	220	300	280	280	280	270	250	.....	(a)	220
14	250	220	220	74	280	280	.....	270	250	(a)	(a)	220
15	250	220	220	2,603	280	280	280	270	.....	(a)	(a)	.....
16	250	220	220	2,461	280	.....	280	270	250	(a)	(a)	220
17	250	.....	.....	1,698	280	280	280	270	250	(a)	.....	220
18	250	220	220	1,609	280	280	280	.....	250	(a)	220	220
19	250	220	220	1,400	.....	280	280	270	250	(a)	220	220
20	.....	220	220	1,271	280	280	280	270	(a)	.....	220	220
21	250	220	220	480	.....	280	.....	270	(a)	(a)	220	220
22	250	220	220	664	280	280	280	270	.....	(a)	220	.....
23	250	220	220	358	280	.....	280	270	220	(a)	220	220
24	250	.....	.....	385	280	280	280	270	220	(a)	.....	220
25	250	220	220	385	280	280	280	.....	220	(a)	220	.....
26	250	220	220	385	.....	280	280	270	220	(a)	220	250
27	.....	220	220	385	280	280	280	270	220	.....	220	250
28	250	.....	220	409	280	280	.....	270	220	(a)	.....	250
29	250	.....	220	409	280	280	280	270	.....	(a)	220	14
30	250	.....	220	409	280	.....	280	270	220	(a)	220	264
31	250	.....	.....	.....	280	.....	280	270	.....	(a)	.....	343
Mean	250	223	220	785	287	280	280	273	247	220	220	222

[a] Gates up; natural flow.

Daily discharge, in second-feet, of Cobbosseecontee River, etc.—Continued.

1896.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	270	.....	901	300	280	280	280	250	250	.....	250
2	451	.....	1,959	993	300	280	280	.....	250	250	220	250
3	276	270	2,698	901	.....	280	280	280	250	250	220	250
4	264	270	1,959	856	300	280	.....	280	250	.....	220	250
5	.....	270	1,637	856	300	280	.....	270	250	250	220	250
6	270	270	1,219	856	300	280	280	270	.....	250	220	.....
7	270	270	1,219	856	280	.....	280	270	250	250	220	250
8	270	270	1,226	856	280	280	280	270	250	250	.....	250
9	270	.....	1,368	769	280	280	280	.....	250	250	220	250
10	270	270	1,368	727	.....	280	280	270	250	250	220	250
11	270	270	946	727	280	280	280	270	250	.....	220	250
12	.....	270	1,038	727	280	280	.....	270	250	250	220	250
13	270	270	1,086	727	280	280	280	270	.....	250	220	.....
14	270	270	1,038	812	280	.....	280	270	250	220	220	250
15	270	270	901	812	280	280	280	270	270	220	.....	250
16	270	.....	769	901	280	280	280	.....	270	220	220	250
17	270	270	727	946	.....	280	280	270	270	220	220	250
18	270	270	685	1,188	280	280	280	270	250	.....	250	250
19	.....	270	856	1,236	280	280	.....	270	250	220	250	250
20	270	270	993	1,039	280	280	280	270	.....	220	250	.....
21	270	270	1,581	901	280	.....	280	270	250	220	250	250
22	270	270	1,429	992	280	280	280	270	250	220	.....	250
23	270	.....	1,275	1,039	280	280	280	.....	250	220	250	250
24	270	280	1,056	901	.....	280	280	270	250	220	250	250
25	270	280	728	769	280	280	280	270	250	.....	250	.....
26	.....	280	686	644	280	280	.....	270	250	220	.....	250
27	270	280	812	526	280	280	280	270	.....	220	250	.....
28	270	280	769	300	280	.....	280	270	250	220	250	250
29	270	280	727	300	280	280	280	270	250	220	.....	250
30	270	.....	644	300	.....	280	280	.....	250	220	250	250
31	270	.....	727	.....	.....	.....	280	250	.....	220	.....	250
Mean	277	272	1,138	812	284	280	280	270	252	232	233	250

1897.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	250	250	250	497	280	600	280	.....	280	280	270	270
2	250	250	250	517	.....	477	280	280	280	280	270	270
3	.....	250	250	574	368	573	280	280	280	.....	270	270
4	250	250	250	350	624	523	.....	280	280	280	270	270
5	250	250	250	620	630	477	100	280	.....	280	270	.....
6	250	250	250	650	320	262	280	280	280	280	270	270
7	250	.....	.....	650	320	336	280	280	280	280	.....	270
8	250	250	250	650	320	336	280	.....	280	280	270	270
9	250	250	250	620	74	320	280	280	280	280	270	270
10	.....	250	250	620	373	320	280	280	280	.....	270	270
11	250	250	250	650	393	512	.....	280	280	280	270	270
12	250	250	250	590	393	559	280	280	.....	280	270	.....
13	250	250	250	421	393	679	280	280	280	280	270	270
14	250	.....	.....	310	.....	679	280	280	280	270	.....	270
15	250	250	250	356	489	436	280	.....	280	(a)	270	270
16	250	250	250	522	244	354	280	280	280	(a)	270	270
17	.....	250	250	497	509	320	280	280	280	(a)	270	270
18	250	250	250	497	833	294	.....	280	280	(a)	270	280
19	250	550	250	473	769	286	280	280	.....	(a)	270	.....
20	250	250	250	453	739	6	280	280	280	(a)	270	280
21	250	.....	.....	320	709	286	280	280	280	(a)	.....	280
22	250	250	250	294	391	436	280	.....	280	(a)	270	280
23	250	250	250	286	6	654	280	280	280	(a)	270	280
24	.....	250	250	280	280	365	280	280	280	.....	270	280
25	250	250	250	14	280	294	.....	280	280	270	270	21
26	250	250	250	286	280	286	280	280	.....	270	270	.....
27	250	250	250	280	280	.....	280	280	280	270	270	280
28	250	.....	.....	286	320	280	280	280	280	270	.....	280
29	250	.....	250	286	15	280	280	.....	280	270	270	280
30	250	.....	250	280	914	280	280	280	280	270	270	280
31	.....	.....	306	.....	772	.....	280	280	.....	.....	.....	280
Mean	250	250	252	438	425	397	273	280	280	276	270	265

(a) Gates up; natural flow.

Daily discharge, in second-feet, of Cobbosseecontee River, etc.—Continued.

1898.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	280	280	413	.....	478	280	280	280	270	250	250	250
2	.....	280	394	.....	478	280	280	280	270	.....	250	250
3	280	280	443	1,016	478	280	.....	280	270	250	250	250
4	280	280	408	1,038	455	280	19	280	.....	250	250	.....
5	280	280	408	1,038	455	.....	280	280	250	250	250	270
6	280	.....	387	1,038	433	280	280	280	250	250	.....	270
7	280	280	466	1,038	433	280	280	.....	250	250	250	270
8	280	280	529	1,038	273	280	280	280	250	250	250	270
9	.....	280	503	1,038	333	280	280	280	250	.....	250	270
10	280	280	474	1,003	333	280	.....	280	250	250	250	270
11	280	280	456	584	314	280	280	280	.....	250	250	.....
12	280	280	559	531	300	.....	280	280	250	250	250	270
13	280	.....	597	326	300	280	280	280	250	250	.....	270
14	280	280	821	326	300	280	280	.....	250	250	250	270
15	280	280	1,148	334	.....	280	280	280	250	250	250	270
16	.....	300	1,111	376	300	280	280	270	250	.....	250	270
17	280	300	1,039	413	300	280	.....	270	250	220	250	270
18	280	300	969	433	300	280	280	270	.....	220	250	.....
19	280	300	969	433	300	.....	280	270	250	220	250	270
20	280	300	1,016	433	300	280	280	270	250	220	.....	270
21	280	328	1,222	433	300	280	280	.....	250	220	250	270
22	280	328	1,184	433	.....	280	280	270	250	220	250	270
23	.....	333	1,147	433	300	280	280	270	250	.....	250	270
24	280	445	1,222	433	300	280	.....	270	250	220	.....	270
25	280	504	1,261	555	280	280	280	270	.....	220	250	.....
26	280	477	1,222	732	280	.....	280	270	250	220	250	270
27	280	435	1,125	682	280	280	280	270	250	220	.....	270
28	280	433	1,147	478	280	280	280	.....	250	250	250	270
29	280	.....	1,184	478	.....	280	280	270	250	250	250	270
30	.....	.....	1,147	620	280	280	280	270	250	.....	250	270
31	280	.....	1,147	.....	280	.....	.....	270	.....	250	.....	270
Mean	280	324	843	633	337	280	270	275	252	238	250	268

1899.

1	.....	270	270	300	300	280	280	280	270	(a)	160	160
2	270	270	270	306	300	280	.....	280	270	(a)	180	160
3	270	270	270	306	300	280	280	280	.....	(a)	180	.....
4	270	270	270	306	300	.....	19	280	270	(a)	170	180
5	270	.....	.....	359	300	280	280	280	250	(a)	.....	180
6	270	270	270	373	300	280	280	.....	250	(a)	180	180
7	270	270	250	395	.....	280	280	280	250	(a)	175	170
8	.....	270	270	502	300	280	280	280	250	(a)	170	150
9	270	270	270	842	300	280	.....	280	(a)	(a)	170	135
10	270	270	270	1,198	300	280	280	280	.....	(a)	150	.....
11	270	270	270	1,262	300	.....	280	280	250	(a)	150	120
12	270	.....	.....	984	300	280	280	280	250	(a)	.....	120
13	270	270	270	772	300	280	280	.....	250	(a)	150	120
14	270	270	270	809	.....	280	280	280	(a)	(a)	150	120
15	.....	270	270	809	290	280	280	280	(a)	(a)	140	120
16	270	270	270	787	290	280	.....	270	(a)	(a)	130	140
17	270	270	270	947	290	280	280	270	.....	(a)	130	.....
18	270	270	270	1,243	290	.....	280	270	250	(a)	130	140
19	270	.....	.....	1,387	290	280	280	270	(a)	(a)	.....	135
20	270	270	270	1,427	290	280	280	.....	(a)	(a)	160	135
21	270	270	270	1,403	.....	280	280	270	(a)	(a)	170	135
22	.....	270	270	1,331	280	280	280	270	(a)	(a)	180	135
23	270	270	270	1,145	20	280	.....	270	(a)	(a)	180	135
24	270	270	270	1,130	280	280	280	270	.....	(a)	180	.....
25	270	270	270	870	280	.....	280	270	220	(a)	180	.....
26	270	.....	.....	669	280	280	280	270	(a)	(a)	.....	150
27	270	270	270	635	280	280	280	.....	(a)	(a)	170	150
28	270	270	270	470	.....	280	280	270	(a)	(a)	165	140
29	.....	.....	280	324	280	280	280	270	(a)	(a)	150	140
30	270	.....	280	.....	280	280	.....	270	(a)	(a)	.....	140
31	270	.....	280	.....	280	.....	280	270	.....	.....	.....	.....
Mean	270	270	270	803	281	280	270	275	252	.....	162	144

[a] Gates up; natural flow.

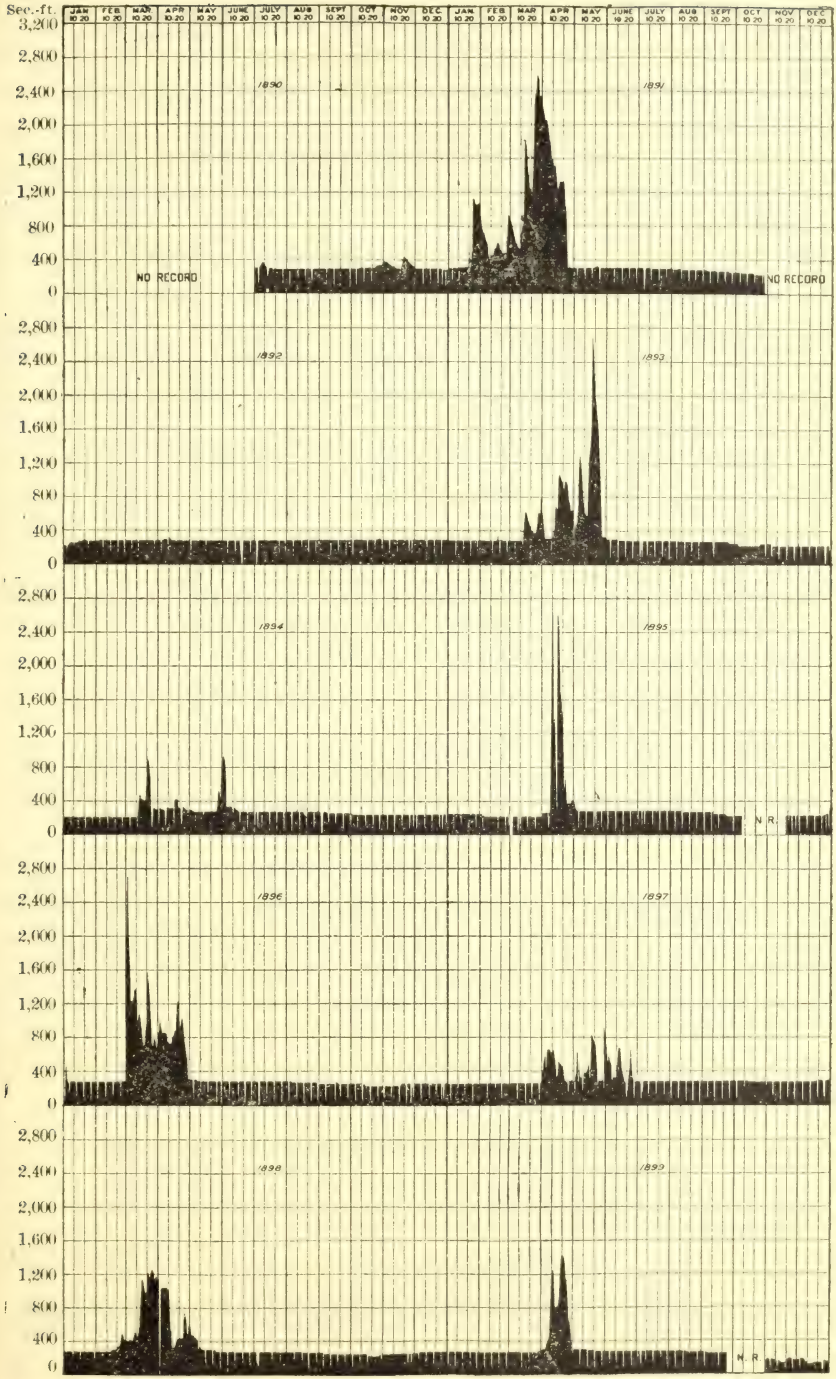


FIG. 6.—Discharge of Cobbosseecontee River at the upper dam near Augusta, Me., 1890 to 1899.

Daily discharge, in second-feet, of Cobbosseecontee River, etc.—Continued.

1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	130	220	815	776	300	300	(a)	260	260	230	180	220
2	130	220	1,463	495	300	300	280	260	(a)	220	165	(a)
3	130	220	2,316	417	300	(a)	280	260	260	190	140	220
4	125	(a)	2,055	656	413	300	(a)	260	260	175	(a)	220
5	125	220	1,911	977	803	280	280	(a)	240	175	130	220
6	125	220	1,622	907	934	280	280	260	240	150	130	220
7	(a)	220	1,481	1,087	831	280	280	260	240	(a)	130	220
8	130	220	1,295	1,379	606	280	(a)	260	240	160	130	220
9	110	220	1,155	1,380	456	280	280	260	(a)	175	200	(a)
10	100	220	1,155	1,342	413	(a)	280	260	240	180	220	220
11	90	(a)	1,153	1,297	348	280	280	260	240	190	(a)	220
12	90	220	1,116	1,297	300	280	280	(a)	240	220	220	240
13	90	220	1,037	1,297	(a)	280	280	260	235	220	220	240
14	(a)	2,194	999	1,297	300	280	280	260	230	(a)	220	230
15	100	1,573	999	1,297	300	280	(a)	260	230	220	220	230
16	95	1,283	999	1,213	300	280	280	260	(a)	220	220	(a)
17	90	856	1,615	1,105	300	(a)	280	260	250	220	220	240
18	90	562	1,611	1,072	300	280	280	260	250	220	(a)	240
19	90	425	1,473	1,260	300	280	280	(a)	250	220	220	240
20	90	294	1,518	1,380	585	280	280	260	250	220	220	240
21	(a)	270	1,811	1,338	704	280	280	275	245	(a)	220	240
22	140	270	1,662	1,260	998	280	(a)	275	250	220	220	240
23	160	270	1,517	1,223	1,325	280	280	275	(a)	220	220	(a)
24	200	270	1,472	1,223	1,422	(a)	280	275	250	220	220	240
25	200	(a)	1,334	1,182	1,301	280	270	275	250	220	(a)	(a)
26	200	564	1,289	869	1,016	280	260	(a)	250	220	220	240
27	200	662	1,206	570	456	280	260	275	250	220	220	240
28	(a)	776	1,206	377	357	280	260	275	245	(a)	220	240
29	220	.....	1,105	(a)	300	280	(a)	275	230	220	220	240
30	220	.....	1,015	300	300	280	260	260	(a)	220	220	(a)
31	220	.....	925	.....	300	.....	260	260	.....	200	.....	240
Mean	136	508	1,365	1,044	562	282	276	264	245	206	199	232

a Water shut back on Sunday when under control.

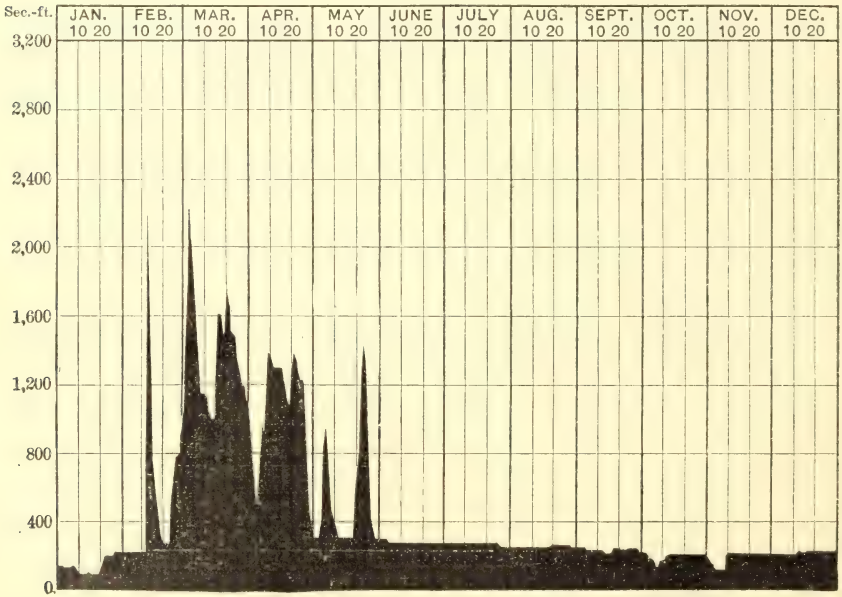


FIG. 7.—Discharge of Cobbosseecontee River at upper dam near Augusta, Me., 1900.

Daily discharge, in second-feet, of Cobbosseecontee River, etc.—Continued.

1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	240	220	120	535	260	510	280	280	(a)	270	250	(a)
2	240	220	120	439	260	483	280	280	280	270	250	220
3	250	(a)	(a)	646	260	439	280	280	280	250	(a)	220
4	250	220	120	1,439	260	303	(a)	(a)	280	250	250	220
5	250	220	120	2,118	(a)	303	280	280	280	250	250	220
6	(a)	220	120	2,343	260	304	280	280	280	(a)	250	220
7	250	220	120	2,089	260	300	(a)	280	280	250	250	220
8	250	220	120	3,111	280	300	280	280	(a)	250	250	(a)
9	250	220	120	3,205	280	280	280	280	280	250	250	220
10	250	(a)	(a)	3,050	280	280	280	280	280	250	(a)	220
11	240	200	130	2,872	280	280	280	(a)	280	250	250	220
12	240	200	170	2,649	(a)	280	280	280	280	250	250	220
13	(a)	200	200	2,580	280	280	280	280	280	(a)	250	220
14	220	200	220	2,534	280	280	(a)	280	270	250	250	220
15	220	180	220	2,339	280	280	280	280	(a)	250	250	(a)
16	220	180	220	2,213	280	(a)	280	280	270	250	250	2,700
17	220	(a)	(a)	2,089	280	280	280	280	270	250	(a)	2,600
18	220	125	220	2,034	280	280	280	(a)	270	250	250	1,143
19	220	125	220	1,921	(a)	280	280	280	270	250	250	999
20	(a)	125	220	1,756	280	280	280	280	270	(a)	250	270
21	220	125	220	1,143	280	280	(a)	280	270	250	250	270
22	220	125	250	999	280	280	280	280	(a)	250	250	(a)
23	220	125	250	1,194	280	(a)	280	280	270	250	250	270
24	220	(a)	(a)	1,296	280	280	280	280	270	250	(a)	270
25	220	125	276	1,194	280	280	280	(a)	270	250	250	270
26	220	125	524	1,046	26	280	280	280	270	250	250	270
27	(a)	120	919	907	286	280	280	280	270	(a)	220	270
28	220	120	1,404	1,109	286	280	(a)	280	270	250	(a)	270
29	220	.....	1,262	985	354	280	280	280	(a)	250	220	(a)
30	220	.....	824	260	393	(a)	280	280	270	250	220	284
31	220	.....	569	.....	483	.....	280	280	.....	250	.....	1,143
Mean	231	173	344	2,046	290	306	280	280	274	252	246	526

a Water shut back on Sunday when under control.

The following tables give the maximum, minimum, and mean monthly discharge of Cobbosseecontee River, and the rainfall and run-off of the basin. The means are computed for working days only, except when lakes are full and water is allowed to flow over the dams; but the run-off in second-feet per square mile and in depth in inches is computed for the full number of days in the month.

Estimated monthly discharge of Cobbosseecontee River at upper dam near Augusta, Me.

[Drainage area, 230 square miles.]

Month.	Discharge in second-feet.			Run-off.		Rainfall, in inches.
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.	
1890.						
June 16 to 30	356	300	324	1.41	1.57	3.71
July	374	290	302	1.14	1.31	4.83
August	290	280	290	1.06	1.22	3.47
September	290	290	290	1.13	1.26	5.13
October	393	290	313	1.23	1.42	5.47
November	445	300	356	1.50	1.67	1.89
December	300	290	298	1.09	1.26	5.55
1891.						
January	1,120	290	516	2.10	2.43	8.10
February	942	363	576	2.41	2.51	3.89
March	2,585	515	1,385	6.02	6.94	7.03
April	2,169	300	1,277	5.55	6.19	2.89
May	316	300	301	1.10	1.27	2.60
June	300	300	300	1.13	1.26	3.64
July	300	290	293	1.06	1.22	5.27
August	290	285	286	1.04	1.20	2.97

Estimated monthly discharge of Cobbosseecontee River, etc.—Continued.

Month.	Discharge in second-feet.			Run-off.		Rainfall, in inches.
	Maximum.	Minimum.	Mean.	Second feet per square mile.	Depth in inches.	
1891.						
September	285	260	272	1.02	1.14	1.00
October	260	(a)				2.40
November	(a)	(a)				2.66
December	220	(a)				5.27
The year						47.72
1892.						
January	276	220	258	0.94	1.08	5.52
February	280	270	279	1.04	2.12	2.21
March	280	280	280	1.06	1.22	2.43
April	306	280	283	1.07	1.19	1.05
May	280	280	280	1.10	1.27	4.62
June	280	280	280	1.02	1.14	7.22
July [b]	280	280	280	0.79	0.91	3.18
August	280	280	280	1.06	1.22	8.11
September	280	280	280	1.06	1.18	4.48
October	280	280	280	1.02	1.18	1.81
November	280	280	280	1.02	1.14	4.54
December	280	280	280	1.06	1.22	1.49
The year	306	220	278	1.02	14.87	46.66
1893.						
January	280	280	280	1.02	1.18	2.70
February	280	280	280	1.09	1.13	4.79
March	780	280	422	1.71	1.97	3.18
April	1,079	300	629	2.65	2.96	2.52
May	2,680	307	1,025	4.46	5.15	4.66
June	300	280	287	1.08	1.21	2.56
July	280	280	280	0.98	1.13	1.12
August	280	270	272	1.03	1.19	3.27
September [c]	270	250	263	0.60	0.67	3.23
October [c]	250	220	236	0.56	0.65	5.90
November	250	220	225	0.82	0.92	1.83
December	220	220	220	0.77	0.89	5.13
The year	2,680	220	368	1.40	19.05	40.89
1894.						
January	220	220	220	0.84	0.97	3.30
February	220	220	220	0.82	0.85	1.99
March	900	220	364	1.48	1.71	1.44
April	430	300	303	1.19	1.33	1.86
May	862	280	333	1.31	1.51	5.84
June	925	280	350	1.42	1.58	1.18
July	280	280	280	0.98	1.13	2.30
August	280	280	280	1.06	1.22	3.08
September	280	270	272	0.94	1.05	3.81
October	270	250	251	0.91	1.05	4.25
November	250	250	250	0.91	1.02	2.21
December	250	250	250	0.88	1.01	2.80
The year	925	220	281	1.06	14.43	34.06
1895.						
January	250	250	250	0.95	1.10	2.50
February	250	220	223	0.80	0.83	1.64
March	220	220	220	0.71	0.82	2.48
April	2,619	250	785	3.41	3.81	4.83
May	385	280	287	1.05	1.21	1.50
June	280	280	280	1.02	1.14	2.01
July	280	280	280	1.02	1.18	4.55
August	280	270	273	1.04	1.20	3.28
September	270	(d)				1.21
October	220	(d)				1.82
November	220	(d)				6.85
December	343	220	222	0.97	1.12	4.40
The year	2,619					37.07
1896.						
January	451	270	277	1.01	1.16	0.87
February	280	270	272	1.02	1.10	5.25
March	2,698	644	1,138	4.95	5.71	7.19

[a] Water so low only gage record kept.
[b] Water shut back eleven days.
[c] Water shut back fourteen days.
[d] Gates up; natural flow; not measured.

Estimated monthly discharge of Cobbosseecontee River, etc.—Continued.

Month.	Discharge in second-feet.			Run-off.		Rainfall, in inches.
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.	
1896.						
April	1,236	300	812	3.53	3.94	2.02
May	300	280	284	0.99	1.14	2.80
June	280	280	280	1.06	1.18	1.94
July	280	280	280	1.02	1.18	3.18
August	280	250	270	0.98	1.13	2.88
September	270	250	252	0.95	1.06	7.60
October	250	220	232	0.88	1.01	2.64
November	250	220	233	0.81	0.90	4.12
December	250	250	250	0.91	1.05	1.52
The year	2,698	220	382	1.51	20.56	42.01
1897.						
January	250	250	250	0.91	1.05	4.51
February	250	250	250	0.93	0.97	2.13
March	306	250	252	0.96	1.11	4.30
April	650	280	438	1.90	2.13	2.86
May	914	244	425	1.73	1.99	5.94
June	679	280	397	1.67	1.86	4.32
July	280	100	273	1.04	1.20	3.15
August	280	286	280	1.02	1.18	2.66
September	280	280	280	1.06	1.18	3.11
October	280	(a)	.....	.....	.....	0.92
November	270	270	270	1.01	1.13	5.99
December	280	21	265	1.00	1.15	3.83
The year	914	.....	.....	.....	.....	43.72
1898.						
January	280	280	280	1.02	1.18	5.54
February	504	280	324	1.31	1.36	5.45
March	1,261	387	843	3.67	4.23	1.76
April	1,038	326	633	2.75	3.07	3.44
May	478	273	337	1.33	1.53	1.60
June	280	280	280	1.06	1.18	3.56
July	280	19	270	0.98	1.13	0.98
August	280	270	275	1.05	1.21	3.73
September	270	250	252	0.95	1.06	2.90
October	250	220	238	0.86	1.99	6.23
November	250	250	250	0.91	1.02	4.57
December	270	250	268	1.02	1.18	2.74
The year	1,261	19	354	1.41	19.14	42.50
1899.						
January	270	270	270	0.98	1.13	3.41
February	270	270	270	1.00	1.04	3.10
March	280	250	270	1.02	1.18	5.56
April	1,427	300	803	3.49	3.90	1.19
May	300	20	281	1.06	1.22	1.87
June	280	280	280	1.06	1.18	2.43
July	280	19	270	0.98	1.13	5.48
August	280	270	275	1.04	1.16	1.08
September	270	(a)	.....	.....	.....	3.90
October	(a)	(a)	.....	.....	.....	1.85
November	180	130	162	0.58	0.65	2.42
December	180	120	144	0.51	0.59	2.61
The year	.....	.....	.....	.....	.....	34.90
1900.						
January	220	90	136	0.51	0.59	7.19
February	2,194	220	508	1.97	2.05	8.96
March	2,316	815	1,365	5.93	6.83	7.23
April	1,380	300	1,044	4.38	4.88	2.50
May	1,422	300	562	2.36	2.73	5.42
June	300	280	282	1.07	1.19	1.34
July	280	260	276	0.97	1.12	1.87
August	275	260	264	1.00	1.15	2.77
September	260	230	245	0.89	0.99	2.45
October	230	150	206	0.78	0.90	4.47
November	220	130	199	0.75	0.84	5.28
December	240	220	232	0.81	0.93	1.64
The year	2,316	90	443	1.79	24.20	51.12

[a] Gates up; natural flow; not measured.

Estimated monthly discharge of Cobbosseecontee River, etc.—Continued.

Month.	Discharge in second-feet.			Run-off.		Rainfall, in inches.
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.	
1901.						
January	250	220	231	0.87	1.00	3.78
February	220	120	173	0.65	0.68	1.76
March	1,404	120	344	1.31	1.51	6.25
April	3,205	260	2,046	8.90	9.90	6.43
May	483	260	290	1.10	1.27	3.97
June	510	280	306	1.20	1.34	1.36
July	280	280	280	1.02	1.18	4.26
August	280	280	280	1.06	1.22	5.54
September	280	270	274	0.99	1.10	2.08
October	270	250	252	0.96	1.11	4.18
November	250	220	246	0.89	0.99	2.41
December	2,700	220	526	1.92	2.21	9.43
The year	3,205	120	437	1.74	23.51	51.45

Run-off, in second-feet per square mile, of Cobbosseecontee River at dam of Gardiner Water Company, near Augusta, Me.

[Drainage area, 230 square miles.]

Month.	1890.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.	1901.	Average.
January	.....	2.10	0.94	1.02	0.84	0.95	1.01	0.91	1.02	0.98	0.51	0.87	1.01
February	.....	2.41	1.04	1.09	0.82	0.80	1.02	0.93	1.31	1.00	1.97	0.65	1.19
March	.....	6.02	1.06	1.71	1.48	0.71	4.95	0.96	3.67	1.02	5.93	1.31	2.62
April	.....	5.55	1.07	2.65	1.19	3.41	3.53	1.90	2.75	3.49	4.38	8.90	3.53
May	.....	1.10	1.10	4.46	1.31	1.05	0.99	1.73	1.33	1.06	2.36	1.10	1.60
June	1.41	1.13	1.02	1.08	1.42	1.02	1.06	1.67	1.06	1.06	1.07	1.20	1.18
July	1.14	1.06	0.79	0.98	0.98	1.02	1.02	1.04	0.98	0.98	0.97	1.02	1.00
August	1.06	1.04	1.06	1.03	1.06	1.04	0.98	1.02	1.05	1.04	1.00	1.06	1.04
September	1.13	1.02	1.06	0.60	0.94	.....	0.95	1.06	0.95	.....	0.89	0.99	0.96
October	1.23	.....	1.02	0.56	0.91	.....	0.88	.....	0.86	.....	0.78	0.96	0.90
November	1.50	.....	1.02	0.82	0.91	.....	0.81	1.01	0.91	0.58	0.75	0.89	0.92
December	1.09	.....	1.06	0.77	0.88	0.97	0.91	1.00	1.02	0.51	0.81	1.92	0.99
The year	.....	.....	1.02	1.40	1.06	.....	1.51	.....	1.41	.....	1.79	1.74	1.42

Ratio of run-off to rainfall in basin of Cobbosseecontee River.

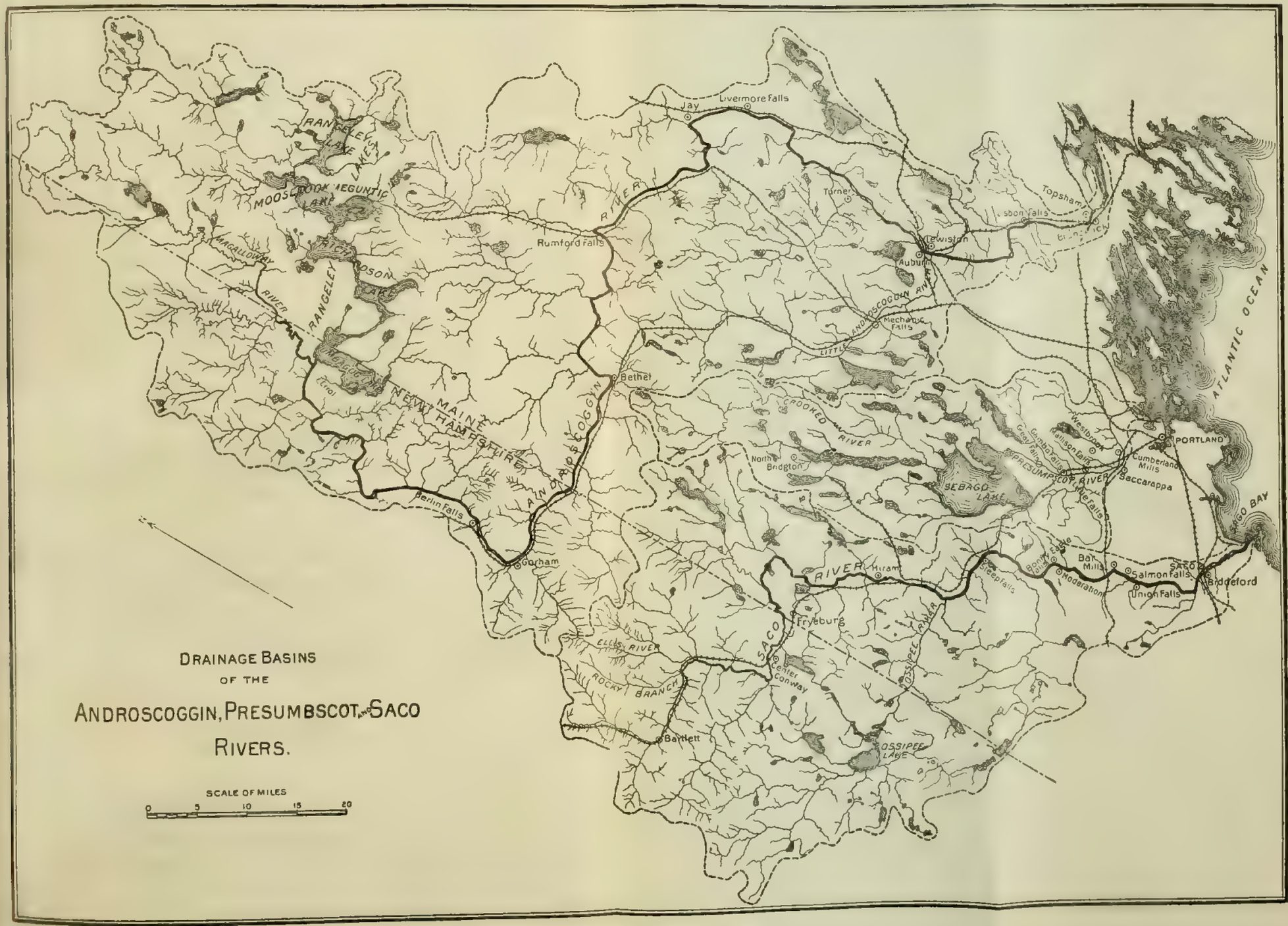
	1890.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.	1901.	Average.
Precipitation, inches	[a]30.05	[b]37.39	46.66	40.89	34.06	[b]27.19	42.01	[c]42.80	42.50	[d]29.15	51.12	51.45	[e]44.10
Run-off, inches	[a]9.71	[b]24.16	14.87	19.05	14.43	[b]12.41	20.56	[c]14.95	19.14	[d]13.18	24.20	23.51	[e]19.25
Ratio	[a]0.32	[b]0.65	0.32	0.47	0.42	[b]0.46	0.49	[c]0.35	0.45	[d]0.45	0.47	0.46	0.44

[a] Seven months.
[b] Nine months.
[c] Eleven months.
[d] Ten months.
[e] Only full-year records used in obtaining averages.

ANDROSCOGGIN RIVER.

DRAINAGE BASIN.

Androscoggin River is formed by the junction of Magalloway River and the outlet of the Umbagog-Rangeley lakes near the Maine-New


DRAINAGE BASINS
OF THE
ANDROSCOGGIN, PRESUMBSCOT, SACO
RIVERS.
SCALE OF MILES
0 5 10 15 20
Livermore Falls
Jay
Rumford Falls
Turner
Lewiston
Auburn
Topsham
Mechanic Falls
Bethel
North Bridgton
Berlin Falls
Gorham
Hiram
Fryeburg
Center Conway
Bartlett
Westbrook
Cumberland Mills
Saccarappa
PORTLAND
Bar Mills
Salmon Falls
Union Falls
Biddeford
Moderation
Sebago
Sebago Lake
Rangeley Lake
Moosehead Lake
Umbagog Lake
Ossipee Lake
Magalloway River
Androscoggin River
Little Androscoggin River
Crooked River
Presumpscot River
Saco River
Ossipee River
Ellis River
Rocky Branch
Maine
New Hampshire
Atlantic Ocean
Casco Bay

Hampshire boundary line. For about 35 miles it flows southward, into the State of New Hampshire, then turns abruptly to the east and flows into the State of Maine, then turns to the south and joins the Kennebec in Merrymeeting Bay. (See Pl. X.) The total drainage area above Brunswick, where is the last fall, is 3,700 square miles, about 80 per cent of which is in Maine. The greatest length of the basin is 110 miles, the greatest width 70 miles, while the river itself measures about 200 miles in length from the sources of Magalloway River to the coast. The following table gives the drainage areas of the river at various points, and of some of its chief tributaries:

Drainage areas of Androscoggin River and principal tributaries.

River.	Locality.	Dainage area.
		Sq. miles.
Androscoggin	Immediately below junction of Umbagog outlet and Magalloway River.	1,180
Do	Berlin Falls	1,480
Do	Rumford Falls	2,220
Do	Livermore Falls	2,690
Do	Lewiston	3,120
Do	Brunswick	3,700
Little Androscoggin	Mouth	380
Magalloway	Mouth	420
Umbagog outlet	Immediately above junction with Magalloway River	760

The lower part of the basin is hilly and moderately wooded, while the upper two-thirds is very broken and mountainous, heavily timbered, and with a gravelly, sandy soil. Granite, gneiss, and mica-schists abound along the main course of the river, with clay slate in the upper part of the basin. The bed of the river, like that of all streams on the southern slopes of Maine, is generally rocky, particularly where falls occur, with high banks, seldom subject to overflow, all of which are features of advantage in the development of water powers. Below Berlin Falls the stream is nowhere more than 10 miles from a railroad, and for considerable portions of its course it is immediately skirted by railroads. Tide-water navigation extends about 6 miles above the mouth, or to the falls at Brunswick.

LAKE STORAGE.

Nearly one-seventeenth of the total area of the basin is in lake surfaces, there being 148 lakes, with an aggregate area of 312 square miles. The largest of these is the Umbagog-Rangeley series, four large bodies of water discharging one into another and finally into the Androscoggin, commanding at the foot of the chain a drainage area of 760 square miles, exclusive of the Magalloway, or 1,180 square miles including that stream, and comprising a combined water surface of at least 80 to 90 square miles. To regulate the flow, the Union

Water Power Company, of Lewiston, has built a dam below the mouth of the Magalloway, by means of which the waters of the latter stream can be turned back into Umbagog Lake. The annual variation in the level of Rangeley Lake, as the highest lake of the chain is known, is seldom as great as 3 feet, but from the Mooselookmeguntic, the second lake, 25 feet lower than Rangeley Lake, the available draft from the high-water level is stated to be 18 feet. From Richardson Lake, the third lake of the series, lying about 20 feet lower than the preceding lake, 22 feet can be drawn, and from Umbagog, the lowest lake of the chain, and lying about 200 feet lower than Richardson Lake, 12 feet. Besides the lakes of the Umbagog-Rangeley chain there are many others of smaller size, ranging in extent from 6 or 8 square miles downward, and covering in the aggregate, according to Wells, about 136 square miles of surface.

The exceedingly mountainous character of the upper basin, with its extensive exposures of bare rock, tends to give the river a high freshet discharge and a variable flow, a tendency which is offset to a considerable extent by the dense forest covering, the large lake storage, and the holding back, by means of dams, of the freshet waters above Rumford Falls. Wells gives the range between high and low water as 8 or 10 feet on the falls at Brunswick and Lewiston, 20 feet at Rumford Falls, and from 22 to 28 feet at Bethel. But at Rumford Falls there is no record of such a rise as that stated. In April, 1895, when the water at other points along the river was as high as any of the traditions declared it had ever been, the rise on the dams at Rumford Falls was only 10.80 feet.

WATER POWERS.

In general the elevation of the basin is greater than that of any other watershed on the Atlantic coast. The outlet of Umbagog Lake is at an elevation of 1,256 feet, while the Rangeley Lakes are about 1,500 feet above the sea. The sources of Magalloway River are from 2,600 to 2,900 feet in elevation. Thus the entire fall of the river, from the level of Umbagog Lake to tide water at Brunswick, amounts to about 1,250 feet, and in the various stretches for which detailed figures are obtainable the fall ranges generally between 4½ and 7½ feet to the mile. At three important points, however, there are large concentrated falls, namely, at Lewiston, where a natural fall of 38 feet in 600 feet is increased to 50 feet by a dam; at Rumford Falls, where there is a natural descent of 177 feet in about a mile, and at Berlin Falls, where the fall is said to amount to nearly 200 feet in a mile. The following table gives the elevations at various points:

UPPER AND LOWER DAMS AT RUMFORD FALLS.

Fall in Androscoggin River.

Locality.	Distance from tide water at Brunswick.	Height above mean tide.	Fall between points.	Distance between points.	Average fall per mile between points.	Authority.
	Miles.	*Feet.*	*Feet.*	*Miles.*	*Feet.*	
Foot of Umbagog Lake	158	1,256				Wells: The Water-Power of Maine, p. 79.
			208	31	6.7	
Head of Berlin Falls	127	1,048				
			281	6	47.0	Joseph Hobson, chief engineer Grand Trunk Railway.
Gorham, N. H	121	[a] 767				
			77	11	7.0	
State line	110	690				Wells: The Water-Power of Maine, p. 79.
			70	12	5.8	
Bethel	98	620				
			23	22	1.0	C. A. Mixer, engineer Rumford Falls Power Company.
Head of Rumford Falls	76	597				
			177	1		
Foot of Rumford Falls	75	420				
			256	53	4.8	
Lewiston, head of Falls	22	[b] 164				H. C. Robinson, assistant engineer Maine Central Railroad.
			164	22	7.5	
Brunswick	0	0				

[a] Water surface at summer stage at Grand Trunk Railway crossing.
[b] Corrected for water surface from elevation of track at Maine Central Railroad bridge.

The amount of power utilized on the Androscoggin in 1880 was given in the census report of that year as from 13,000 to 14,000 horse-power. The increase since that time has been very great, as shown by figures given herein. The total amount now used is greater than upon any other stream in New England. Probably more than two-thirds of it is employed in the manufacture of wood pulp and paper, and it is almost exclusively in that line that the development of the river in recent years has taken place. This growth seems natural when it is considered that the Upper Androscoggin Basin contains the finest spruce forests in New England. In the third annual report of the forest commissioner of Maine, Mr. Austin Cary places the net area of spruce-producing land in the Androscoggin Basin in Maine at 830 square miles, not more than half of which has been cut for spruce, while the 850 square miles or thereabouts of the gross area of the basin lying in New Hampshire is or has been a spruce-bearing region. Large inroads are, however, now being made into the spruce of this basin, as well as of others in Maine, and it is hoped that before the scarcity of this wood is felt too severely either the State or the companies will appreciate the advantages of careful cutting under the supervision of a trained forester. Under the guidance of an expert, cutting could go on from year to year without seriously affecting the available supply, but if all the forests are ruthlessly cut the spruce of Maine will be entirely destroyed in the not distant future, and the great industries depending upon that wood will cease.

Ascending from the mouth of the river, the first fall is at the head of tide water at Brunswick. Here there is a dam giving a fall of

about 15 feet, which is liable to a reduction of about 3 feet from the tide. The largest user of power is the Bowdoin Paper Manufacturing Company, employing 750 horsepower on the north bank, where there is also a sash, door, and blind factory. At the south or Brunswick end of the dam are the mills of the Androscoggin Pulp Company, a gristmill, a sawmill, a sash and blind factory, and a ferrule shop. The aggregate power used could not be learned.

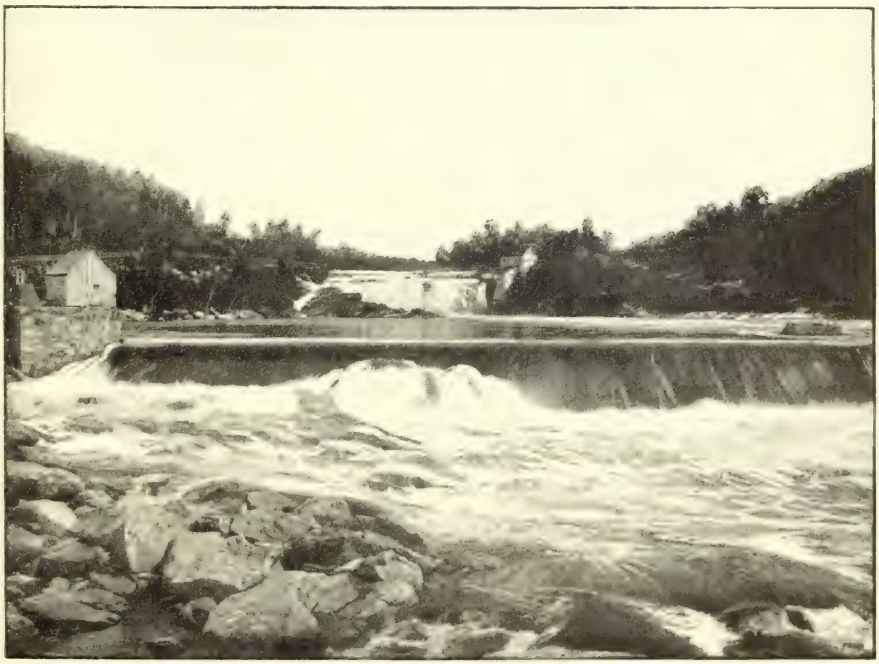
The second or upper dam at Brunswick is a short distance above the dam just mentioned, and gives a fall of 18 feet. This privilege is owned by the Cabot Manufacturing Company, which uses 1,700 horsepower in its cotton mills and leases power to the Brunswick Electric Light Company, lighting Brunswick and Topsham, and employing two 500-horsepower turbines. No lack of water at this privilege has ever been experienced.

A half mile above the Cabot Manufacturing Company's dam are rapids with a fall of 7 feet; and a few miles farther is the Pejebscot Mills privilege, which has been developed within the last three or four years for the manufacture of pulp and paper, and at which a fall of 20 feet and 4,000 horsepower are in use.

At Lisbon Falls, about 11 miles below Lewiston, there are two dams. At the lower dam 14 feet fall and 875 horsepower are utilized by the Lisbon Falls Paper Manufacturing Company, while at the upper dam 13 feet fall and 1,050 horsepower are employed, about three-fourths of it in the woolen mill of the Worumbo Manufacturing Company.

The next power is that at Lewiston, 22 miles by river above tide water at Brunswick, owned by the Union Water Power Company. At this point the river had naturally a fall over a rocky bed of about 38 feet in a few hundred feet, and by a dam at the head of the falls this has been raised to 50 feet. Above the dam the pond is only 1½ miles in length, and is of insufficient capacity to store completely the night flow in dry weather. The power is used on the left bank from two levels, the upper canal being 4,200 feet long and the lower canal 1,600 feet long. The city of Lewiston has the right to 450 horsepower net for pumping its water supply from the river, and to 150 horsepower net for the purpose of electric street lighting. The water-power company also maintains on the lower level a mill from which it leases considerable quantities of power. The main employment of power, however, is by large cotton mills (comprising the Continental, the Androscoggin, the Bates, the Hill, the Lewiston, the Lincoln, and the Avon), the Lewiston bleachery and dye works, and the Cowan & Company, the Columbia, and the Cumberland woolen mills. Power is leased by the water-power company at rates varying from $5 to $12.50 per horsepower per annum, the cheaper rates being for the original corporations. The price applies to net power on the shaft, assuming the latter to be 75 per cent of the gross power of a given

A. UPPER DAM AT RUMFORD FALLS.



B. LOWER DAM AT RUMFORD FALLS, AT ENTRANCE TO MIDDLE-LEVEL CANAL.

quantity of water and fall. The mills run sixty hours a week, and measurements of the water power used by them are made daily. Some auxiliary steam power is also in use at some of the mills.

The total demand for water from the upper level when all of the plants are running at full capacity is between 3,100 and 3,200 cubic feet per second for about sixty hours a week. Assuming 3,150 cubic feet per second used on the full fall of 50 feet, we find the corresponding power to be about 18,000 gross or 13,500 net horsepower; but as some water is used on only a part of the total fall, the utilized power is reckoned at from 15,000 to 16,000 gross, or, say, 12,000 net horsepower sixty hours in the week. For a large part of the year the available power is of course much in excess of the figures given.

At Deer Rips a dam is being constructed which will make available a fall of 28 feet; this is to be utilized for electric power in Lewiston. At the Crooked Rips, 5 or 6 miles above Lewiston, opposite the town of Turner, there is a dam, built a few years ago, giving a moderate fall, but now serving no useful purpose.

The next utilized power is at Livermore Falls, about 25 miles above Lewiston, where approximately 3,000 horsepower is in use, the major portion of it (2,500 horsepower) in the mills of the Livermore Falls and Umbagog pulp companies, and the remainder temporarily in an electric-light station. The head realized is about 16 feet, but rapids extending downstream indicate that a considerable additional fall (about 25 feet) is available.

In the 25 miles between Livermore Falls and Rumford Falls are three large water powers devoted to the manufacture of pulp and paper. At Otis Falls 24 feet fall and 8,000 horsepower are employed by the Otis Falls Pulp Company, which has developed 18 feet fall farther upstream, at the Petersons Rips, where 6,000 horsepower is available. Between these two privileges, at Jay, the Jay Paper Manufacturing Company uses 15 feet fall and 3,700 horsepower.

At Rumford Falls there is one of the finest water powers on the Atlantic coast. Here the Androscoggin descends 177 feet in 1 mile, in several pitches over granite ledges. A comprehensive plan of development has been laid out and partially executed. It contemplates the use of power from three levels—a high-level canal, with a fall of 97 feet, to the middle level, the latter receiving also a direct and independent supply of water from the river, the water to be used from the middle-level canal and discharged, after a fall of 50 feet, into the low level, from which in turn there is a final drop of 30 feet to the river. Dams have been built at the entrance of the high and middle level canals. (See Pls. XI and XII.) Water for power was first used in important amounts in the summer of 1893, and its use increased from time to time, so that at present about 19,000 horsepower is in use, the greater part being utilized in the manufacture of pulp and paper. (A view of the city, looking downstream toward the

middle-level canal, is shown in Pl. XIII, *A*, and a description of the works is given in the Nineteenth Annual Report of the United States Geological Survey, Part IV.) If the entire fall of 177 feet were utilized there would be available, at Rumford Falls, from 30,000 to 54,000 horsepower. This power is 85 miles, by rail, from Portland, and for pulp and paper manufacture has the advantage of excellent transportation facilities—Androscoggin River, for floating down pulp wood and timber from the headwaters to the mills, and the Rumford Falls and Rangeley Lakes Railroad, extending into the forests, with a contemplated extension into the Megantic region which will make available additional spruce, poplar, and birch forests. Altogether Rumford Falls possesses the greatest water power in the New England States. Much of it is now unutilized, but it is likely that before long the city of Rumford Falls will be a great manufacturing center.

Passing upstream, the next use of power on the Androscoggin is at Berlin Falls, N. H., where the river has a rapid descent over a rocky bed, stated to be nearly 200 feet in 1 mile. The first power is that of the Glen Manufacturing Company, which has 3 dams in succession, giving falls of 22, 22, and 38 feet, the power being employed in the manufacture of paper and pulp. Then follows an unimproved privilege, succeeded by the works of the Burgess Sulphite Fiber Company, using a fall of 16 feet. Above these are the paper, pulp, and saw mills of the Berlin Mills Company, which obtain power from 3 dams, the aggregate fall being about 50 feet. The mills at Berlin are among the largest of their kind in the country. They employ in the aggregate about 20,000 horsepower of turbines, and their combined output in twenty-four hours comprises about 140 tons of wood pulp, 210 tons of sulphite fiber, and 160 tons of finished news paper. In addition to this the Berlin Mills Company manufactures about 40,000,000 feet of finished lumber per annum.

Above Berlin Falls no power is used from the Androscoggin, and the stream is without immediate railroad facilities. There is a dam, however, at Pontoocook Falls, 10 or 12 miles above Berlin, used for logging purposes, and within about 2 miles of which there is said to be 60 or 70 feet of fall in the river. At Errol, also, there is a dam which serves to control the storage in Umbagog Lake, as elsewhere mentioned.

FLOW.

No figures of value regarding the flow of Androscoggin River are available, except those resulting from a series of observations begun at Rumford Falls in May, 1892, during the progress of power developments at that place, and continued to the present time. Until January, 1893, the discharge was determined from the computed flow over the dam, as given by the Francis ordinary weir formula, modified for the form of the crest. Subsequent to that time, as water came to be used for power, additions of the amounts assumed to pass through the turbines were made to the computed flow over the dam.

A. RUMFORD FALLS, LOOKING DOWNSTREAM TOWARD MIDDLE-LEVEL CANAL.

B. SACO RIVER BELOW SALMON FALLS DAM.

Gage ratings are taken at the lower dam. At first they were made once a day, later four times a day, and now every two hours. Flashboards are not used on the dam. There is but little fluctuation during the twenty-four hours in the quantity passing the weirs; in fact, there is not much fluctuation anywhere upon the river except at and below Lewiston, where a large proportion of the mills run only in the daytime, while elsewhere the mills run continuously through the week. At Rumford Falls many of the turbines run throughout the week without change of gate, and some of them run for a month or two at a time without stopping. Notwithstanding the fact that a high degree of accuracy is not expected, and doubtless is not claimed for results obtained by this method, in which, for example, the proper weir coefficient to be used is in doubt, the results obtained at Rumford Falls are of high value as giving a good approximation of the actual volume of the river. The measurements, which are given in accompanying tables, have been placed at the disposal of the Survey by Mr. Charles A. Mixer, resident engineer of the Rumford Falls Power Company.

The year 1899 was remarkable for its small rainfall. According to Mr. Mixer, the departure of the precipitation of that year from the normal, which is taken as 43.41 inches, was a deficiency of 27 per cent, the total fall being only 31.58 inches. This emphasizes the importance of water storage, not only to tide over these rare periods of deficient flow, but also to equalize the fluctuations from month to month during every year. The lowest monthly run-off, 0.71 inch in depth, was in August, the month of greatest evaporation, and it was 0.07 inch more than the precipitation. The lowest daily discharge for the year, 1,124 second-feet, was 0.48 second-foot per square mile. The total annual run-off averaged 53 per cent of the total precipitation as measured at Rumford Falls, but in 1899 the percentage rose to 59, the increase presumably being due to storage. The records of precipitation have not been kept for a sufficiently long period to give a wide range in fluctuation, but judging from the effects on the wells there had been no such period of drought for from fifty to seventy-five years. The following table gives a comparison of the rainfall at Rumford Falls for the year 1899, with the normal rainfall of the years preceding:

Comparison of rainfall at Rumford Falls, Me.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Normal	3.23	4.28	3.55	2.99	3.92	3.63	4.48	3.49	3.34	2.78	4.74	2.98
1899	3.18	2.56	5.89	1.50	1.59	2.27	4.71	0.64	3.00	2.05	1.94	1.95
Normal accumulation	3.23	7.51	11.06	14.05	17.97	21.60	26.08	29.57	32.91	35.69	40.43	43.41
1899 accumulation	3.18	5.74	11.63	13.13	15.02	17.29	22.00	22.64	25.64	27.69	29.33	31.58
Accumulated excess	.....	.....	0.57	.....	.....	.....	.....	.....	.....	.....	.....	.....
Accumulated deficiency	0.05	1.77	.....	0.88	2.95	4.31	4.08	6.93	7.27	8.00	10.80	11.83

During the year there are generally two low-water seasons, one in January and the other in September. The two periods of low water are each short, thus reducing the requirements for storage, and resulting in rapid increase of efficiency of every storage project. Observations of rainfall at Rumford Falls give the results shown in the following table. These figures include rain and melted snow, and can not be considered strictly representative of the precipitation over the whole catchment basin, as the elevation of the rain gage is 512 feet, while the catchment surface is higher, ranging from 600 feet upward in the portion of the drainage basin which is without storage, which aggregates about half of the entire area. The other half of the basin, within which are lakes and other facilities for storage, averages in elevation about 1,450 feet.

Rainfall, in inches, at Rumford Falls, Me.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1893	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3.00	.....
1894	2.40	1.85	1.57	1.20	5.55	3.20	5.15	4.30	4.35	3.95	4.25	2.70	40.47
1895	3.50	0.60	1.06	5.60	4.40	2.30	2.15	3.10	2.05	1.60	5.40	5.71	37.47
1896	1.10	5.85	9.75	1.65	2.07	1.75	2.75	3.15	4.40	3.20	2.95	0.95	39.57
1897	3.80	2.70	4.05	3.35	4.25	6.20	9.44	2.15	1.93	0.63	5.35	3.40	47.25
1898	3.85	7.25	1.08	2.87	2.55	3.05	2.70	3.39	3.96	4.52	5.00	1.95	42.17
1899	3.18	2.56	5.89	1.50	1.89	2.27	4.71	0.64	3.00	2.05	1.94	1.95	31.58
1900	5.80	7.96	5.82	1.21	4.57	3.35	4.35	2.42	2.31	3.91	7.22	1.15	50.07
1901	2.77	0.74	4.05	7.91	6.54	3.84	4.91	3.47	2.59	3.48	1.76	5.53	47.59

In addition to the annual storage in lakes there is another form of storage resulting from the prevailing low temperature of the basin. The winter precipitation, which is chiefly in the form of snow, is nearly all retained for a period of weeks or months, and by melting in the spring is rapidly added to the rainfall of that season. Thus the ratio between rainfall and run-off during the winter and spring means little or nothing. By yearly periods, however, the comparison, as shown in the following table, is of interest:

Ratio of run-off to rainfall in basin of Androscoggin River.

	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.	1901.	Average.
Rainfall, inches	[a]31.86	36.26	39.48	37.27	39.83	45.36	42.17	31.58	50.07	47.59	41.07
Run-off, inches	[a]17.47	27.34	22.29	20.91	22.60	23.91	22.04	18.37	22.66	24.87	22.78
Ratio	[a]0.55	0.75	0.56	0.56	0.57	0.53	0.52	0.58	0.45	0.52	0.56

[a] Seven months—June to December.

The records of discharge of the Androscoggin indicate on the whole a very constant flow, maintained for more than half of the time between 2,000 and 4,000 cubic feet per second, and between substantially 1 and 2 cubic feet per square mile of drainage area.

It is true that during February and March, 1895, the discharge continued as low as about 1,200 cubic feet per second, or 0.55 cubic foot per second per square mile. This is described, however, as a very unusual condition, resulting from the withdrawal of lake storage in the early winter until it was exhausted, for the first time since the dams were built at the lakes, a period of twenty-five years, followed by severe and continued cold weather, holding all surface moisture in the form of snow and ice and even checking the flow of springs. On the other hand, within ten days after the close of this period of low flow, or in April, 1895, the river was visited by a freshet described by Mr. Mixer as the highest in thirty years. The discharge rose to 55,000 cubic feet per second, or about 25 cubic feet per second per square mile of drainage area. The ratio of these extremes, about 45 to 1, is probably not unlike that for other reservoir-fed streams of New England, such as the Merrimac and the Connecticut, but it is widely different from that of Southern nonreservoir streams, such as the Potomac.

Daily discharge, in second-feet, of Androscoggin River at Rumford Falls, Me.

[Drainage area, 2,320 square miles.]

1892.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1						6,500	16,300	3,200	5,860	2,700	2,580	3,830
2						7,000	11,800	3,450	5,860		2,820	3,580
3						5,540		3,450	5,240	2,700	3,060	2,820
4						6,500	16,700	3,450		2,700	4,080	
5						6,150	17,500	3,450	4,940	2,940	3,830	3,050
5						6,150	14,800	3,450	4,940	2,940		3,580
7						6,150	12,600		4,350	2,940	2,820	3,580
8						5,540	12,000	3,320	4,080	2,700	3,060	3,830
9						5,540	11,000	2,820	3,580		5,860	3,830
10						4,360		2,820	3,580	2,700	4,650	3,200
11						4,080	10,000	2,600		2,700	3,320	
12						4,350	9,300	4,080	3,200	2,700	2,820	3,200
13						3,830	6,500	4,350	3,200	2,700		3,200
14						3,830	6,500		3,200	2,700	2,330	3,200
15						3,830	5,240	5,870	8,000	2,700	2,580	3,200
16						4,080	4,940	5,870	4,940		4,650	2,940
17						3,830		4,940	4,080	2,700	24,500	2,940
18					5,860	4,080	4,650	4,940		2,700	13,000	
19					5,550	3,830	3,830	4,350	3,300	2,700	16,300	2,940
20					4,940	4,080	4,080	4,650	3,050	2,700		2,940
21					4,940	11,000	3,700		2,580	2,700	8,300	2,940
22					5,540	11,200	3,700	5,540	3,060	2,700	7,500	2,940
23					7,500	7,500	3,700	4,650	3,830		5,550	2,940
24					11,700	6,500		4,650	3,330	2,940	4,950	2,940
25					9,300	7,000	3,950	4,350		2,940	4,080	
26					8,600	13,000	3,950	8,500	3,080	2,940	4,350	
27					8,900	11,300	3,580	8,500	3,830	2,940		2,940
28					9,300	15,800	3,320		3,580	2,940	4,350	2,940
29					8,600	19,900	2,820	8,500	3,060	2,940	3,830	3,200
30					8,000	19,900	4,660	8,500	3,060		3,580	3,200
31					8,500			6,500		2,700		3,200
Mean					7,660	7,410	7,730	4,840	4,030	2,780	5,720	3,200

Daily discharge, in second-feet, of Androscoggin River, etc.—Continued.

1893.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	2,990	2,990	2,870	9,560	5,040	3,310	2,840	3,760	.....	3,570	3,820
2	3,580	2,990	2,750	.....	11,460	5,040	.....	2,840	3,260	2,900	3,570	2,860
3	3,580	2,990	2,750	3,250	11,460	4,450	3,310	3,080	.....	2,450	3,340	.....
4	3,830	2,990	2,750	3,250	11,760	.....	3,580	2,840	2,560	2,450	3,340	1,900
5	3,200	.....	.....	2,750	25,460	4,750	3,630	2,580	2,360	2,860	.....	2,260
6	2,940	2,990	2,750	2,750	17,060	4,750	3,580	2,840	2,560	2,660	3,080	2,260
7	2,940	2,990	2,990	2,750	.....	5,040	3,580	3,820	2,760	2,260	3,080	2,860
8	.....	2,990	2,990	2,750	14,260	6,250	3,310	3,820	3,270	.....	3,340	2,460
9	2,940	2,990	2,990	.....	14,260	4,750	.....	2,840	3,530	2,750	3,340	2,460
10	2,940	2,990	2,990	5,910	17,060	5,040	3,310	2,840	.....	2,660	2,870	.....
11	3,200	2,990	2,990	4,700	24,060	.....	3,580	2,580	2,560	2,860	2,670	2,260
12	3,200	.....	.....	5,910	27,860	9,700	2,590	2,580	2,560	2,660	.....	2,060
13	3,200	2,990	3,250	7,050	27,860	8,400	2,590	2,840	3,040	2,660	2,670	2,260
14	3,200	2,990	4,130	7,050	.....	7,100	2,120	2,370	2,350	4,340	2,460	2,260
15	.....	2,990	4,130	8,050	28,460	7,100	2,310	1,960	2,160	.....	2,670	2,460
16	3,200	2,990	3,880	.....	25,060	6,660	.....	1,600	2,570	6,840	2,770	2,460
17	3,200	2,990	3,250	5,000	30,460	5,650	2,310	1,600	.....	3,580	2,770	.....
18	3,200	2,990	3,250	4,700	38,060	.....	2,120	1,750	3,280	4,320	2,770	2,460
19	3,200	.....	.....	4,700	26,060	4,450	2,590	2,580	3,280	3,670	.....	2,460
20	3,200	2,990	3,250	4,400	21,060	5,950	2,590	2,870	2,560	3,080	2,860	2,460
21	3,200	2,990	3,250	5,000	.....	5,100	2,820	3,560	2,560	3,080	2,860	2,460
22	.....	2,990	3,250	5,290	16,760	5,350	2,590	3,060	2,360	.....	3,340	2,260
23	3,200	2,990	3,250	.....	14,260	5,350	.....	3,060	2,160	3,340	3,080	2,260
24	3,200	2,990	2,990	5,590	13,060	5,740	2,590	3,060	.....	4,330	2,680	.....
25	3,200	2,990	2,990	5,910	9,660	.....	2,810	4,080	2,300	13,000	2,060	3,820
26	3,200	.....	.....	5,590	8,860	8,400	3,070	4,850	2,360	6,450	.....	2,860
27	3,200	2,990	3,370	6,550	6,560	6,250	2,590	4,080	3,040	4,320	1,900	3,340
28	2,940	2,990	3,380	7,050	.....	5,640	2,590	3,320	2,150	4,060	2,460	3,080
29	.....	.....	3,110	7,050	5,610	3,680	2,820	3,080	2,350	.....	4,830	3,080
30	2,940	.....	3,370	.....	5,610	3,160	2,330	12,300	2,350	4,830	4,320	3,080
31	2,940	.....	3,060	.....	5,110	.....	2,820	4,850	.....	3,820	.....	.....
Mean	3,180	2,990	3,190	5,030	17,290	5,720	2,870	3,300	2,690	3,935	3,030	2,630

1894.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3,570	2,130	1,680	.....	13,730	9,430	.....	1,680	1,980	1,680	7,380	1,880
2	3,570	2,130	1,570	4,290	13,730	9,830	3,110	1,750	.....	1,570	5,060	1,980
3	2,290	1,980	1,570	4,050	14,230	.....	2,280	1,980	1,830	1,730	4,560	1,980
4	2,290	.....	.....	4,050	11,730	9,830	5,310	2,130	1,980	1,980	.....	2,030
5	2,490	2,130	1,980	3,570	10,530	6,730	3,810	.....	1,980	1,680	5,060	2,030
6	2,700	2,130	2,130	3,900	9,730	5,880	3,090	1,380	1,930	1,460	4,050	2,180
7	.....	1,980	3,310	3,570	8,530	5,580	2,280	1,680	1,830	.....	3,300	2,280
8	2,490	2,130	5,880	.....	8,530	5,310	.....	2,030	1,680	1,680	2,890	1,570
9	2,490	2,280	5,310	3,570	7,730	4,810	2,480	2,280	.....	1,780	3,100	.....
10	2,280	2,130	5,310	3,300	7,380	.....	2,700	2,480	3,800	5,580	2,930	1,980
11	2,280	.....	.....	3,570	7,080	4,810	2,480	2,130	2,890	4,050	.....	1,830
12	2,280	2,280	4,550	3,570	5,880	3,100	3,310	.....	1,980	2,890	3,300	2,480
13	2,130	1,680	5,310	3,570	.....	4,060	2,280	1,830	1,630	3,800	2,890	2,890
14	.....	1,980	3,800	3,570	5,070	4,060	2,130	1,980	1,630	.....	2,280	2,730
15	2,280	1,680	4,560	4,300	4,550	3,800	.....	2,130	1,680	3,100	2,730	2,530
16	2,280	2,310	3,800	5,880	4,550	3,800	2,480	2,130	.....	2,690	2,530	.....
17	2,130	1,680	3,570	7,730	5,070	.....	2,280	2,130	1,680	2,890	2,730	2,280
18	2,130	.....	.....	9,030	4,810	4,550	2,480	2,280	1,830	2,890	.....	2,030
19	2,130	1,980	3,570	12,530	4,570	6,170	1,980	.....	2,180	2,530	3,100	2,130
20	3,310	1,980	5,570	17,730	.....	5,310	1,830	2,130	5,880	2,480	1,830	2,730
21	.....	1,980	7,090	22,230	6,170	5,310	3,300	1,980	3,310	.....	1,930	2,330
22	3,310	1,830	5,570	.....	6,170	4,550	.....	1,880	2,480	2,280	2,700	1,460
23	3,310	1,680	5,310	20,630	5,880	3,800	1,980	1,680	.....	2,280	2,700	.....
24	3,570	1,680	4,300	19,230	5,880	.....	1,830	1,680	2,280	2,280	2,890	1,880
25	3,570	.....	.....	18,730	6,470	3,100	1,830	1,730	2,130	2,330	.....	2,030
26	3,310	1,680	4,300	16,530	11,630	3,100	2,130	.....	1,830	2,690	2,490	1,980
27	3,310	1,680	4,050	15,230	.....	3,100	2,130	1,680	1,880	2,130	1,680	1,480
28	.....	1,570	3,800	16,930	5,880	4,050	2,280	1,680	1,830	.....	2,130	1,880
29	2,890	.....	3,570	.....	5,070	4,600	.....	1,880	1,680	2,180	1,460	1,980
30	2,890	.....	3,800	14,930	19,230	4,050	1,830	1,830	.....	2,280	1,380	.....
31	2,280	.....	3,570	.....	10,830	.....	1,680	2,030	.....	.....	.....	1,830
Mean	2,720	1,950	4,030	9,470	8,240	5,100	2,510	1,930	2,230	2,500	3,040	2,090

Daily discharge, in second-feet, of Androscoggin River, etc.—Continued.

1895.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2,130	1,460	1,230	1,330	10,780	5,030	2,010	1,870	.....	6,380	1,730	4,970
2	2,180	1,380	1,230	1,230	9,060	.....	2,000	1,980	1,400	3,700	2,160	4,870
3	2,130	.....	.....	1,230	7,780	4,430	1,950	2,000	1,450	2,570	2,310	5,980
4	2,130	1,330	1,230	1,330	9,060	4,350	2,300	.....	1,860	2,570	1,860	2,870
5	2,530	1,230	1,230	1,230	.....	4,010	2,090	1,900	1,710	2,690	1,860	2,850
6	.....	1,230	1,230	1,230	9,350	3,760	1,890	1,860	1,700	.....	1,860	2,810
7	2,130	1,230	1,230	2,130	8,330	3,400	.....	1,660	1,840	2,360	2,020	2,830
8	2,030	1,230	1,230	3,100	7,570	3,230	2,020	1,640	.....	2,200	2,530	2,580
9	1,980	1,230	1,230	15,030	7,770	.....	2,000	1,600	1,550	2,200	2,290	2,400
10	1,830	.....	.....	9,730	7,880	3,100	1,960	1,760	1,710	2,200	6,440	2,190
11	1,680	1,230	1,230	6,790	6,390	2,700	2,010	.....	1,620	2,180	5,190	2,250
12	1,570	1,230	1,230	5,570	.....	2,170	1,920	2,080	2,070	2,020	2,970	2,440
13	.....	1,230	1,230	8,730	17,070	2,060	1,890	2,000	2,130	.....	2,470	1,890
14	1,630	1,230	1,230	.....	11,570	2,380	.....	1,860	1,600	5,130	2,300	1,890
15	2,490	1,230	1,230	55,230	8,730	2,580	1,880	1,770	.....	3,980	2,230	2,070
16	2,130	1,230	1,230	38,230	7,770	.....	1,840	1,730	1,780	2,770	3,540	1,990
17	1,630	1,230	1,230	17,630	7,480	3,000	1,740	1,720	1,620	2,550	3,010	2,260
18	1,430	1,230	1,230	13,530	6,700	2,360	1,760	.....	1,530	2,350	2,520	2,220
19	2,480	1,230	1,230	12,030	.....	2,240	1,760	1,990	1,580	2,200	2,800	2,350
20	.....	1,230	1,230	12,930	6,290	2,180	1,690	1,900	1,580	.....	2,600	2,280
21	1,460	1,230	1,230	.....	5,630	2,180	.....	1,760	1,630	2,110	3,970	2,270
22	1,480	1,230	1,230	16,530	5,330	2,150	1,490	1,580	.....	1,950	3,060	3,470
23	1,480	1,230	1,230	16,530	5,030	.....	1,350	1,590	1,970	1,880	2,340	9,420
24	1,580	.....	.....	16,530	4,230	2,320	1,350	1,700	2,130	1,830	2,780	5,860
25	1,380	1,230	1,230	14,930	4,230	2,330	1,400	.....	2,240	1,880	2,770	4,500
26	1,380	1,230	1,230	14,930	.....	2,320	1,350	2,000	2,370	1,880	2,640	3,250
27	.....	1,230	1,230	13,730	3,600	2,330	1,350	1,880	2,960	.....	15,650	8,460
28	1,460	1,230	1,230	.....	8,730	2,500	.....	1,770	2,910	1,890	7,870	12,420
29	1,330	.....	1,230	12,930	7,730	2,710	1,750	1,860	.....	1,740	5,760	6,970
30	1,450	.....	1,230	10,730	6,530	.....	1,600	1,890	4,790	1,690	5,470	4,030
31	1,380	.....	.....	.....	5,330	.....	1,580	1,770	.....	1,640	.....	12,640
Mean	1,800	1,250	1,230	12,000	7,628	2,873	1,775	1,819	1,989	2,539	3,566	4,180

1896.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	21,540	1,650	10,630	3,660	12,140	4,530	1,820	1,820	1,620	1,950	1,970	3,240
2	5,470	1,850	39,010	4,050	11,440	4,000	1,840	1,690	1,470	1,910	2,110	1,850
3	5,220	1,690	16,680	4,300	11,380	2,300	1,840	1,970	1,390	1,910	2,040	1,710
4	3,460	1,640	6,510	3,720	11,540	2,270	1,740	1,680	1,480	2,230	1,970	1,700
5	2,110	1,620	4,580	3,390	11,070	3,080	1,680	1,630	1,490	1,890	2,140	2,310
6	2,020	1,810	4,120	3,370	12,180	3,110	1,500	1,970	1,570	1,740	8,100	3,040
7	2,100	1,840	4,440	3,280	11,460	3,530	2,310	2,100	4,760	1,610	6,480	2,470
8	2,320	1,860	4,430	3,330	10,340	3,570	2,080	2,310	2,830	1,540	4,830	2,220
9	2,310	1,770	4,030	3,180	10,200	4,500	2,490	1,970	2,170	1,460	3,610	2,210
10	2,310	1,530	3,340	3,420	10,020	5,760	2,390	1,980	1,520	1,530	3,250	2,340
11	2,320	1,560	3,230	3,900	10,000	5,230	2,140	1,760	2,000	1,700	3,040	2,060
12	2,240	1,620	3,070	4,800	10,860	4,710	1,810	1,660	1,930	1,590	3,320	1,910
13	2,190	1,720	3,000	6,770	9,490	4,020	1,800	1,620	1,830	1,590	3,720	1,930
14	2,230	1,560	2,780	12,310	8,310	3,980	1,960	1,660	1,750	1,600	3,320	2,210
15	2,160	1,730	2,810	14,880	7,690	3,620	1,770	1,710	1,640	1,590	2,710	1,630
16	2,030	1,880	2,600	23,180	7,110	3,260	1,940	2,240	1,420	1,730	2,690	1,620
17	2,040	1,840	2,630	27,390	5,910	3,190	1,960	2,230	1,560	1,660	2,490	1,130
18	2,090	1,920	2,310	25,020	5,470	2,700	1,980	2,450	1,730	1,380	2,460	1,680
19	2,180	1,910	2,310	23,660	5,220	2,650	2,050	2,270	1,740	1,810	2,300	1,820
20	2,190	1,920	2,780	24,550	4,860	2,530	1,890	2,050	1,820	2,180	2,370	1,940
21	2,180	1,800	5,570	25,340	4,760	2,040	2,300	2,260	2,450	2,100	1,690	2,190
22	1,860	1,940	4,680	22,450	4,550	2,220	2,760	1,900	2,390	5,710	1,990	2,150
23	1,930	1,730	4,050	19,550	4,080	2,530	2,190	2,300	2,360	3,720	1,750	2,080
24	1,840	1,440	3,690	18,090	3,970	2,250	2,080	2,190	2,130	3,160	2,280	1,920
25	1,790	1,650	3,270	16,240	3,680	2,100	2,190	1,960	2,180	3,280	2,330	2,040
26	1,540	1,620	3,220	15,500	3,940	1,850	1,680	1,680	1,960	2,450	2,360	1,950
27	1,750	1,600	3,540	14,360	3,870	1,990	2,100	1,660	1,830	2,260	2,380	1,640
28	1,830	1,680	3,830	13,720	4,370	2,130	1,940	1,690	1,810	2,060	2,820	1,580
29	1,680	1,810	4,430	13,170	4,310	1,630	2,040	1,870	1,440	1,960	5,670	1,650
30	1,600	.....	3,610	12,750	4,610	1,770	2,030	1,600	1,500	1,900	3,580	1,990
31	1,870	.....	3,560	.....	4,660	.....	1,750	1,570	.....	2,030	.....	2,030
Mean	2,916	1,731	5,443	12,444	7,532	3,102	2,002	1,918	1,926	2,104	3,062	2,008

Daily discharge, in second-feet, of Androscoggin River, etc.—Continued.

1897.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2,062	1,787	1,816	2,043	16,440	8,023	5,943	5,726	1,291	1,596	1,685	2,180
2	1,851	1,806	1,645	2,290	15,312	7,641	4,956	4,829	1,383	1,455	1,443	1,846
3	1,812	1,766	1,618	2,871	17,981	6,787	3,941	4,428	1,217	1,800	5,686	1,921
4	1,820	1,793	1,554	2,634	19,266	7,235	3,231	3,423	1,234	1,435	3,617	1,877
5	2,257	1,636	1,694	1,914	14,649	7,952	3,271	3,013	1,143	1,328	2,450	2,609
6	4,623	1,653	1,661	2,377	12,818	8,200	3,282	2,798	1,249	1,413	1,780	3,450
7	2,729	1,623	1,652	4,639	11,576	7,379	3,304	2,289	1,298	1,359	1,506	2,784
8	2,022	1,911	1,637	5,573	10,739	7,331	3,483	2,086	1,146	1,441	1,776	2,368
9	1,753	2,228	1,660	4,580	10,104	6,687	3,197	2,240	1,355	1,297	1,820	2,350
10	1,612	2,016	1,673	3,768	11,178	10,523	3,260	2,271	1,375	1,360	2,410	2,357
11	1,814	1,817	1,707	3,891	11,528	14,764	3,011	2,061	1,765	1,414	2,353	2,232
12	1,787	1,635	1,748	3,633	10,359	10,817	2,727	1,993	1,873	1,360	2,090	2,905
13	1,589	1,679	1,814	4,199	11,447	8,982	5,660	1,924	1,596	3,757	1,992	2,382
14	1,574	1,799	1,917	4,737	19,220	10,500	17,505	1,669	1,695	2,363	1,663	2,926
15	1,644	1,644	1,570	5,181	15,333	10,118	22,906	1,385	1,691	1,894	1,653	3,302
16	1,680	1,755	1,688	8,221	11,690	8,414	12,781	2,390	1,543	1,606	1,610	7,462
17	1,706	1,790	1,568	11,435	10,709	7,763	10,015	3,672	1,649	1,610	2,620	5,699
18	1,661	1,694	1,587	9,546	10,469	7,068	8,800	2,828	1,764	1,873	2,717	4,221
19	1,742	1,777	1,732	9,746	9,565	6,303	8,121	2,255	1,395	1,480	2,607	1,965
20	1,320	1,597	1,829	10,736	9,230	5,841	7,380	2,103	1,448	1,619	1,259	1,622
21	1,552	1,055	1,712	7,802	8,771	5,839	6,786	1,994	1,867	1,683	1,223	2,051
22	1,545	1,150	1,688	6,415	8,338	4,917	6,709	1,420	1,961	1,491	1,665	2,129
23	1,680	1,571	2,102	8,230	6,724	4,098	7,657	1,452	1,776	1,544	1,373	2,241
24	1,709	1,604	2,516	11,880	7,338	2,634	6,982	1,619	1,768	1,664	1,218	2,258
25	1,567	1,738	2,387	16,082	7,526	4,345	7,030	1,651	1,833	1,409	1,245	1,797
26	1,400	1,680	2,253	18,986	9,732	4,469	6,721	1,852	2,001	1,504	1,573	1,736
27	1,459	1,516	2,061	17,272	8,895	3,493	5,327	1,755	1,997	1,506	5,295	2,149
28	1,662	1,501	1,883	15,440	12,432	3,405	4,242	1,472	1,941	1,506	5,149	2,086
29	1,476	.....	1,791	15,912	11,383	3,420	4,016	1,368	1,891	1,489	3,039	1,894
30	1,541	.....	1,938	15,359	10,095	4,007	5,560	1,400	1,605	1,336	2,545	1,781
31	1,812	.....	1,995	.....	9,397	.....	6,940	1,342	.....	1,190	.....	1,886
Mean	1,821	1,686	1,810	7,913	11,621	6,998	6,605	2,345	1,592	1,606	2,282	2,536

1898.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2,142	1,823	1,641	8,582	9,925	5,001	2,067	1,601	1,421	2,080	2,508	2,507
2	1,905	1,584	1,601	7,370	9,963	4,643	2,280	1,858	1,493	2,149	2,514	2,519
3	1,815	1,822	1,565	6,772	9,422	4,384	2,192	1,912	1,713	1,961	2,500	2,556
4	1,938	1,949	1,615	6,221	8,941	4,743	2,152	1,589	2,638	1,871	2,463	2,448
5	1,909	2,193	1,573	5,693	8,086	4,462	2,209	2,025	2,151	2,151	2,286	2,290
6	1,953	1,960	1,470	5,262	9,414	4,352	2,132	2,459	1,815	2,122	2,233	2,233
7	2,095	1,741	1,397	4,977	8,591	4,298	2,010	1,974	1,707	2,288	2,155	2,443
8	2,130	1,635	1,462	4,833	8,423	4,694	2,003	1,890	1,776	2,408	2,150	2,196
9	2,118	1,655	1,817	4,962	7,669	6,200	1,960	1,805	1,801	2,038	2,265	2,115
10	2,048	1,606	1,859	5,639	6,746	6,139	1,721	1,639	1,742	1,949	2,203	2,030
11	1,974	1,602	2,147	6,710	6,426	4,669	1,645	1,635	1,440	1,800	2,341	1,910
12	1,858	1,728	2,606	8,243	7,264	4,790	1,808	1,560	1,302	1,889	2,856	1,796
13	1,953	2,109	3,583	10,102	15,566	5,243	1,710	1,495	1,484	1,929	2,715	1,829
14	2,185	1,778	6,894	10,933	13,245	5,662	1,728	1,487	1,509	1,772	2,807	1,940
15	2,041	1,724	7,501	11,849	11,295	7,980	1,736	1,577	1,457	1,803	2,614	2,022
16	2,113	1,758	6,052	12,349	11,882	6,475	1,677	1,567	1,524	2,466	2,569	2,016
17	1,887	1,443	5,055	11,623	11,763	5,964	1,710	1,465	1,595	2,273	2,460	2,007
18	1,854	1,224	4,983	13,272	11,196	5,587	1,463	1,562	1,352	2,415	2,731	2,053
19	1,751	1,577	4,987	11,594	10,996	5,025	1,673	1,583	1,789	2,075	3,720	2,382
20	1,977	1,673	5,195	10,268	10,594	6,596	2,031	2,033	1,893	2,269	6,903	2,107
21	1,927	1,574	9,617	8,504	10,386	5,844	2,194	1,448	1,842	2,600	4,754	1,992
22	1,977	1,577	8,231	7,899	9,216	5,384	2,013	1,517	1,667	2,588	3,698	2,215
23	1,778	1,545	7,365	9,075	9,000	4,914	1,969	1,616	1,555	4,039	3,165	2,319
24	1,764	1,608	8,041	10,057	8,377	3,888	1,526	1,557	2,433	2,312	2,923	2,454
25	1,878	1,549	7,826	16,748	8,666	3,095	1,684	1,560	4,245	2,742	2,816	2,580
26	1,936	1,640	7,442	15,881	7,281	2,837	1,930	1,888	3,534	2,662	2,011	2,290
27	2,038	1,764	7,631	13,083	6,033	2,672	2,261	1,981	2,610	11,529	1,971	2,260
28	1,928	1,763	8,032	11,292	7,243	2,508	1,904	1,744	2,456	6,698	1,840	2,201
29	1,918	.....	9,585	10,266	5,650	2,116	1,599	1,668	2,399	4,585	1,741	1,939
30	1,832	.....	10,096	9,217	5,459	2,117	1,569	1,501	2,077	3,228	2,486	2,047
31	1,764	.....	10,857	.....	5,085	.....	1,812	1,595	.....	2,776	.....	2,176
Mean	1,947	1,700	5,152	9,309	9,026	4,743	1,883	1,703	1,947	2,821	2,746	2,189

Daily discharge, in second-feet, of Androscoggin River, etc.—Continued.

1899.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2,398	1,832	1,926	2,029	24,057	3,773	3,224	1,521	1,359	2,130	2,186	1,230
2	2,441	1,861	1,955	2,088	24,077	3,495	3,600	1,557	1,453	1,784	3,172	1,247
3	1,933	1,736	1,857	1,998	21,468	3,383	2,800	1,492	1,247	1,709	2,865	1,700
4	2,124	1,825	1,791	1,974	19,480	3,400	1,700	1,601	1,455	1,532	2,232	1,792
5	2,255	1,810	1,738	2,024	16,631	3,042	1,510	1,758	1,466	1,566	2,030	1,289
6	2,613	1,789	1,780	2,009	15,111	2,988	1,485	1,717	1,469	1,454	1,925	1,170
7	2,675	1,768	1,978	2,129	14,368	3,574	1,718	1,636	1,434	1,527	2,060	1,290
8	2,275	1,773	2,017	2,436	14,358	3,625	1,823	1,325	1,332	1,330	1,899	1,018
9	2,267	1,619	1,801	2,460	13,970	3,264	1,900	1,442	1,328	1,368	1,843	1,016
10	1,192	1,606	1,712	2,688	12,874	3,295	1,779	1,274	1,141	1,400	1,778	1,010
11	2,074	1,462	1,706	2,954	12,035	3,761	1,934	1,335	1,281	1,482	1,674	1,084
12	1,931	1,812	1,754	3,174	11,182	3,150	1,589	1,357	1,357	1,351	1,230	1,253
13	2,316	1,814	1,646	2,975	10,721	2,984	2,366	1,317	1,319	1,231	1,170	5,274
14	2,059	1,957	2,037	3,054	10,054	3,012	1,818	1,261	1,368	1,452	1,171	3,354
15	2,084	1,981	2,007	4,236	9,122	2,797	1,494	1,209	1,529	1,230	1,516	1,965
16	2,127	1,929	1,913	6,808	7,630	3,494	1,651	1,250	1,274	1,234	1,476	1,626
17	2,135	1,919	1,846	6,490	7,134	3,524	1,270	1,221	1,243	1,413	1,561	1,183
18	2,137	1,920	1,843	7,457	5,960	3,230	1,232	1,326	1,300	1,432	1,343	1,331
19	2,325	1,886	1,834	9,509	5,340	3,186	1,563	1,455	1,470	1,405	1,300	1,781
20	1,924	1,824	1,826	11,127	5,706	3,079	1,173	1,453	1,524	2,096	1,489	1,795
21	1,848	1,899	1,819	11,543	6,497	3,024	1,271	1,349	1,788	1,744	1,860	2,051
22	1,835	1,960	1,823	12,461	6,028	3,529	2,433	1,331	2,043	1,500	1,914	1,929
23	2,093	2,029	1,818	14,599	5,369	3,198	3,682	1,676	2,202	1,368	1,866	1,805
24	2,058	2,111	1,816	17,372	4,821	3,049	1,927	1,462	1,794	1,347	1,825	1,412
25	2,003	1,928	1,818	17,371	4,443	3,060	1,634	1,571	1,124	1,455	1,628	1,298
26	2,106	1,819	1,862	20,017	4,328	2,793	1,490	1,557	1,381	1,443	1,500	1,689
27	1,944	1,816	1,763	23,287	4,019	3,127	1,443	1,265	2,971	1,637	1,370	1,343
28	2,098	1,931	1,831	20,787	4,151	2,717	1,233	1,329	2,397	1,511	1,571	1,278
29	1,697	.....	1,839	21,319	4,465	3,297	1,142	1,382	2,223	2,767	1,382	1,097
30	1,760	.....	1,948	22,920	4,290	3,282	1,170	1,464	2,124	2,548	1,224	1,048
31	1,721	.....	1,976	.....	3,849	.....	1,267	1,372	.....	2,220	.....	1,437
Mean	2,111	1,843	1,848	8,709	10,114	3,238	1,817	1,428	1,580	1,604	1,733	1,606

1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1,231	1,351	3,063	1,830	16,182	5,582	1,780	1,611	1,650	1,985	1,530	3,264
2	1,170	1,295	2,849	1,933	13,249	5,952	1,781	1,560	1,600	1,856	1,466	3,250
3	1,171	1,346	2,791	2,026	12,008	6,850	1,705	1,504	1,650	1,987	1,504	3,059
4	1,190	1,869	2,190	2,561	17,092	7,458	1,640	1,512	1,682	2,137	1,460	3,192
5	1,198	1,362	2,434	2,734	13,700	7,016	1,760	1,500	1,672	2,062	1,479	2,088
6	1,258	1,277	2,136	2,791	10,555	6,196	1,744	1,486	1,603	2,056	1,466	2,173
7	1,224	1,334	2,047	2,592	10,165	6,341	1,791	1,490	1,482	2,079	1,547	2,375
8	1,289	1,354	1,794	4,730	9,121	5,627	1,800	1,505	1,299	2,010	1,694	2,833
9	1,189	1,438	1,810	4,603	8,283	5,550	1,803	1,685	1,264	2,053	10,131	2,030
10	1,115	1,420	1,826	3,836	9,468	4,948	1,798	1,722	1,275	2,006	12,061	1,939
11	1,130	1,654	1,801	3,318	8,024	4,850	1,719	1,620	1,247	2,703	7,525	1,983
12	1,135	1,467	1,768	3,989	7,038	4,509	1,777	1,630	1,273	3,754	5,230	2,339
13	1,211	1,777	1,749	4,138	6,720	4,609	1,781	1,592	1,390	3,197	4,436	2,571
14	1,139	6,009	1,600	4,099	7,734	4,263	1,949	1,648	1,352	2,731	3,870	2,329
15	1,178	5,570	1,772	4,943	10,917	4,113	2,000	1,811	1,332	3,472	3,636	2,470
16	1,147	4,151	1,620	6,230	13,415	4,487	1,880	1,942	1,389	3,615	3,610	2,650
17	1,251	3,599	1,901	8,171	12,062	4,439	2,561	2,009	1,478	3,033	3,104	2,003
18	1,196	2,972	2,549	9,220	13,877	3,015	2,992	1,918	1,667	3,007	3,330	2,071
19	1,181	2,954	2,425	16,130	18,383	2,956	3,168	1,703	1,660	3,255	3,330	2,114
20	1,241	2,562	2,179	22,025	24,531	3,384	3,042	1,714	1,656	2,042	3,893	2,357
21	2,195	2,408	2,491	21,980	22,126	3,311	2,850	1,522	1,658	1,930	6,398	2,215
22	3,221	2,306	2,729	21,317	19,960	2,955	2,885	1,462	1,913	1,509	6,794	2,042
23	2,169	2,146	2,647	21,593	17,632	2,037	2,834	1,437	1,860	1,754	5,819	2,265
24	1,879	2,002	2,255	21,837	16,391	1,948	2,779	1,459	1,860	1,765	4,681	1,764
25	1,765	2,326	1,894	20,250	14,778	1,893	2,844	1,391	1,712	1,676	3,500	2,420
26	1,698	5,157	1,930	17,679	13,408	1,855	2,828	1,318	1,745	1,618	2,934	2,622
27	1,628	4,626	1,819	15,739	12,295	1,855	2,727	1,382	1,697	1,430	3,374	2,300
28	1,382	3,814	1,776	13,458	9,687	1,810	2,530	1,387	2,025	1,430	3,112	1,871
29	1,215	.....	1,836	12,877	9,250	1,931	2,020	1,369	1,930	1,492	2,624	1,983
30	1,285	.....	1,788	13,274	6,973	2,070	1,782	1,413	1,860	1,482	2,834	1,831
31	1,350	.....	1,919	.....	6,632	.....	1,686	1,503	.....	1,500	.....	1,865
Mean	1,408	2,555	2,109	9,763	12,633	4,127	2,201	1,574	1,596	2,213	3,945	2,331

Daily discharge, in second-feet, of Androscoggin River, etc.—Continued.

1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1,872	1,827	1,940	2,887	16,128	6,712	3,355	3,053	1,812	1,696	1,741	1,525
2	1,757	1,826	1,926	3,200	15,173	6,453	3,192	3,024	1,852	1,715	1,605	1,427
3	1,692	1,837	1,934	3,882	14,297	7,223	3,584	2,899	1,721	1,671	1,563	1,563
4	1,872	1,683	2,081	6,303	13,977	7,424	3,670	2,525	1,624	1,725	1,499	1,403
5	1,811	1,641	2,124	8,823	12,634	6,725	3,099	2,941	1,671	1,670	1,600	1,209
6	1,901	1,644	2,087	8,328	11,614	6,051	2,681	2,490	1,643	1,547	1,677	1,340
7	1,890	1,595	2,061	13,694	10,610	5,634	2,850	3,547	1,418	1,768	1,666	1,307
8	2,015	1,563	2,094	17,062	9,472	6,916	3,209	5,035	1,447	2,031	1,649	1,383
9	1,974	1,653	2,191	17,115	8,608	5,909	3,500	4,615	1,518	2,021	1,589	1,390
10	1,908	1,660	2,223	15,115	8,503	5,766	3,432	2,997	1,374	2,060	1,588	1,609
11	1,856	1,764	2,055	15,956	16,044	5,510	3,116	3,377	1,449	1,982	1,576	2,021
12	1,896	2,496	2,070	14,911	16,507	4,598	3,445	3,189	1,609	1,641	1,767	2,087
13	1,935	2,054	2,113	12,811	12,362	3,755	3,120	2,927	1,631	1,705	1,787	1,989
14	1,938	1,949	2,011	12,831	12,068	3,680	1,992	2,802	1,537	3,536	1,829	2,616
15	1,896	1,765	1,961	14,285	10,868	3,450	1,739	2,693	1,442	5,137	1,814	27,785
16	1,956	1,868	1,889	13,694	9,871	3,206	1,784	3,244	1,764	3,818	1,748	22,578
17	2,082	1,885	1,934	13,580	8,854	3,271	2,039	3,135	1,742	2,911	1,640	6,243
18	2,026	1,912	1,943	15,139	8,054	3,040	2,842	2,116	1,666	2,893	1,702	3,515
19	1,833	1,985	1,938	15,181	10,924	2,926	2,833	2,118	1,611	2,859	1,700	2,865
20	1,895	1,969	1,873	14,576	16,808	2,992	2,675	2,453	1,440	2,689	1,692	2,597
21	1,907	1,875	1,980	19,219	11,722	3,584	2,428	2,782	1,521	2,866	1,592	2,473
22	2,002	1,842	2,861	32,653	9,310	3,227	2,054	2,750	1,416	2,640	1,636	2,310
23	1,925	1,855	3,407	30,619	8,186	3,227	1,824	2,682	1,955	2,222	1,637	2,298
24	1,881	1,853	3,046	23,886	7,578	3,297	1,864	2,498	1,787	1,749	1,532	2,518
25	1,917	1,822	2,865	19,065	8,046	3,419	1,822	2,499	1,535	1,803	1,543	2,436
26	1,886	1,776	3,114	18,371	6,711	3,100	1,739	2,443	1,682	1,736	1,425	2,506
27	1,898	1,848	3,720	16,162	6,285	2,831	1,612	2,287	1,343	1,728	1,361	2,528
28	1,858	1,856	4,445	16,062	7,300	2,787	1,844	2,166	1,361	1,770	1,233	2,948
29	1,835	.....	3,845	15,198	8,464	2,868	2,239	2,114	1,489	1,873	1,205	2,643
30	1,823	.....	3,378	16,120	7,910	3,033	3,381	2,090	1,652	1,755	1,590	2,761
31	1,800	.....	3,234	.....	7,248	.....	3,833	1,925	.....	1,753	.....	2,813
Mean	1,895	1,832	2,463	14,891	10,714	4,420	2,671	2,820	1,590	2,224	1,606	3,764

The monthly discharge of the river at Rumford Falls from 1892 to 1901 is given in the following tables, also the rainfall and run-off for the same years. The precipitation given is from records at two stations, viz, West Milan, N. H., and Rumford Falls, Me. The precipitation for 1892 and 1893 is from records at the former station; the records for 1894, 1895, 1896, and 1897 are means of the records taken at the two stations, while the precipitation for 1898 and succeeding years is from records at Rumford Falls.

Estimated monthly discharge of Androscoggin River at Rumford Falls, Me.

[Drainage area, 2,320 square miles.]

Month.	Discharge in second-feet.			Run-off.		Rainfall, in inches.
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.	
1892.						
May 18 to 31	11,700	4,940	7,660	3.30	[a]1.72	3.19
June	19,900	3,830	7,410	3.19	3.56	8.74
July	17,500	2,820	7,730	3.33	3.84	3.66
August	8,500	2,600	4,840	2.09	2.41	8.38
September	5,860	2,580	4,030	1.74	1.94	2.74
October	2,940	2,700	2,780	1.20	1.38	1.88
November	24,500	2,330	5,720	2.47	2.75	4.91
December	3,830	2,820	3,200	1.38	1.59	1.55
1893.						
January	3,830	2,940	3,180	1.37	1.58	1.86
February	2,990	2,990	2,990	1.29	1.34	4.78
March	4,130	2,750	3,190	1.38	1.59	2.89
April	8,050	2,750	5,030	2.17	2.42	2.70
May	38,060	5,110	17,290	7.45	8.59	3.30
June	9,700	3,160	5,720	2.47	2.75	3.12
July	3,630	2,120	2,870	1.24	1.43	2.36
August	12,300	1,600	3,300	1.42	1.64	4.46
September	3,760	2,150	2,690	1.16	1.29	2.67
October	13,000	2,260	3,930	1.69	1.95	3.27
November	4,830	1,900	3,030	1.31	1.46	1.80
December	3,820	1,900	2,630	1.13	1.30	3.05
The year	38,060	1,600	4,654	2.01	27.34	36.26

[a] Partial month.

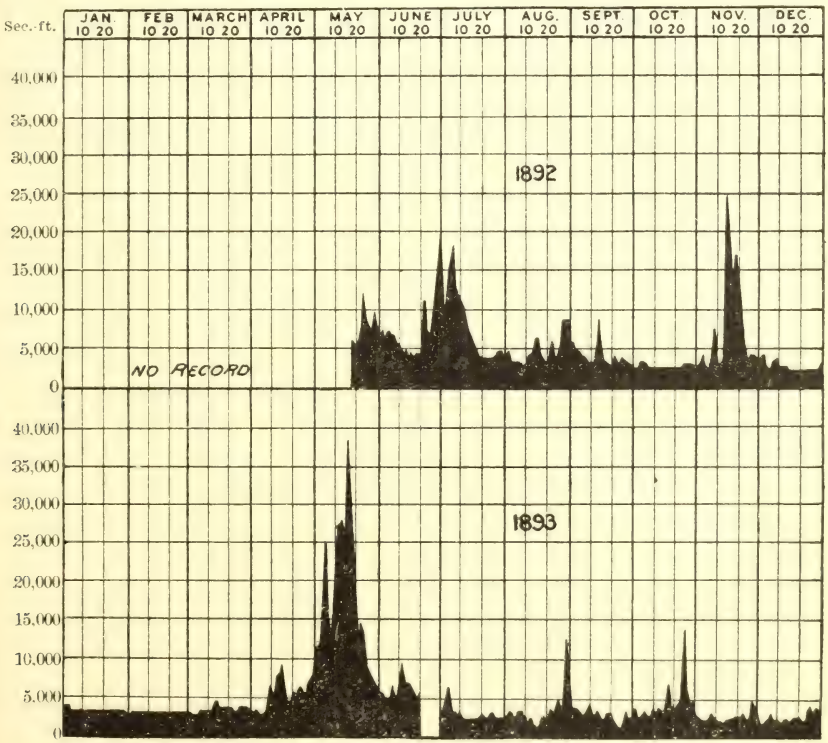


FIG. 8.—Discharge of Androscoggin River at Rumford Falls, Me., 1892 and 1893.

Estimated monthly discharge of Androscoggin River at Rumford Falls, Me.—Continued.

Month.	Discharge in second-feet.			Run-off.		Rainfall, in inches.
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.	
1894.						
January	3,570	2,130	2,720	1.17	1.35	2.87
February	2,310	1,570	1,950	0.84	0.87	3.40
March	7,090	1,570	4,030	1.74	1.94	1.94
April	22,230	3,300	9,470	4.08	4.55	1.62
May	19,230	4,550	8,240	3.55	4.10	4.46
June	9,830	3,100	5,100	2.20	2.45	3.89
July	5,310	1,680	2,510	1.08	1.25	4.31
August	2,480	1,380	1,930	0.83	0.96	3.11
September	5,880	1,630	2,230	0.96	1.07	3.61
October	5,580	1,460	2,500	1.08	1.25	3.24
November	7,380	1,380	3,040	1.31	1.46	3.85
December	2,890	1,460	2,090	0.90	1.04	3.18
The year	22,230	1,380	3,818	1.65	22.29	39.48
1895.						
January	2,530	1,330	1,800	0.78	0.90	3.21
February	1,460	1,230	1,250	0.54	0.56	1.01
March	1,230	1,230	1,230	0.53	0.61	1.27
April	55,230	1,230	12,000	5.17	5.77	4.73
May	17,070	3,600	7,628	3.29	3.80	4.08
June	5,030	2,060	2,873	1.24	1.38	3.15
July	2,300	1,350	1,775	0.77	0.89	2.49
August	2,080	1,580	1,819	0.78	0.90	3.38
September	4,790	1,400	1,989	0.86	0.96	2.01
October	6,380	1,640	2,539	1.16	1.34	1.58
November	15,650	1,730	3,566	1.54	1.72	5.52
December	12,640	1,890	4,180	1.80	2.08	4.84
The year	55,230	1,230	3,554	1.54	20.91	37.27

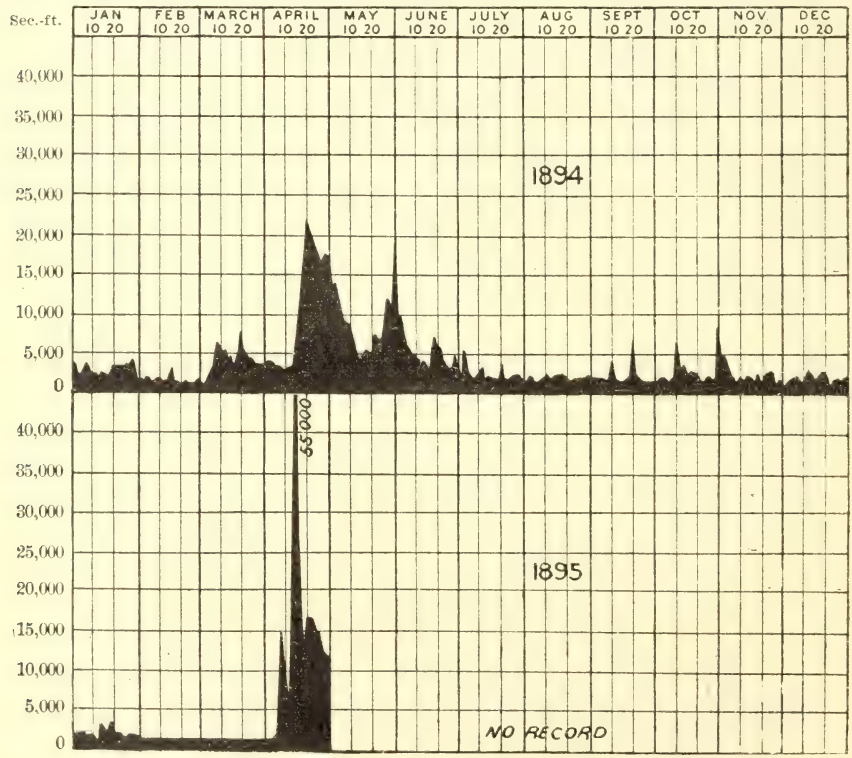


FIG. 9.—Discharge of Androscoggin River at Rumford Falls, Me., 1894 and 1895.

Estimated monthly discharge of Androscoggin River at Rumford Falls, Me.—Continued.

Month.	Discharge in second-feet.			Run-off.		Rainfall, in inches.
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.	
1896.						
January	21,540	1,540	2,916	1.26	1.45	1.70
February	1,940	1,440	1,731	0.75	0.81	5.34
March	39,010	2,310	5,443	2.35	2.71	8.56
April	27,390	3,180	12,444	5.36	5.98	2.16
May	12,180	3,680	7,532	3.25	3.75	2.15
June	5,760	1,630	3,102	1.34	1.50	1.75
July	2,760	1,500	2,002	0.86	0.99	3.54
August	2,450	1,570	1,918	0.83	0.96	3.33
September	4,760	1,390	1,926	0.83	0.93	4.07
October	5,710	1,380	2,104	0.91	1.05	2.91
November	8,100	1,690	3,062	1.32	1.47	3.16
December	3,240	1,130	2,008	0.87	1.00	1.16
The year	39,010	1,130	3,849	1.66	22.60	39.83
1897						
January	4,623	1,320	1,821	0.78	0.90	3.37
February	2,228	1,055	1,686	0.73	0.76	2.45
March	2,516	1,554	1,810	0.78	0.90	3.81
April	18,986	1,914	7,913	3.41	3.80	3.15
May	19,266	6,724	11,621	5.01	5.78	4.43
June	14,764	3,405	6,998	3.02	3.37	6.58
July	22,906	2,727	6,605	2.85	3.29	7.50
August	5,726	1,342	2,345	1.01	1.16	2.30
September	2,001	1,143	1,592	0.69	0.77	2.16
October	3,757	1,190	1,606	0.69	0.80	0.92
November	5,686	1,085	2,282	0.98	1.09	5.43
December	7,462	1,622	2,596	1.12	1.29	3.26
The year	22,906	1,055	4,073	1.76	23.91	45.36
1898.						
January	2,185	1,751	1,947	0.84	0.97	3.85
February	2,193	1,224	1,700	0.73	0.76	7.25
March	10,857	1,397	5,152	2.22	2.56	1.08
April	16,748	4,833	9,309	4.01	4.47	2.87
May	15,566	5,085	9,026	3.89	4.49	2.55
June	7,980	2,116	4,743	2.04	2.27	3.05
July	2,280	1,463	1,883	0.81	0.93	2.70
August	2,459	1,448	1,703	0.73	0.84	3.39
September	4,245	1,302	1,947	0.84	0.94	3.96
October	11,529	1,772	2,821	1.22	1.41	4.52
November	6,903	1,741	2,746	1.18	1.32	5.00
December	2,580	1,596	2,189	0.94	1.08	1.95
The year	16,748	1,224	3,764	4.02	22.04	42.17

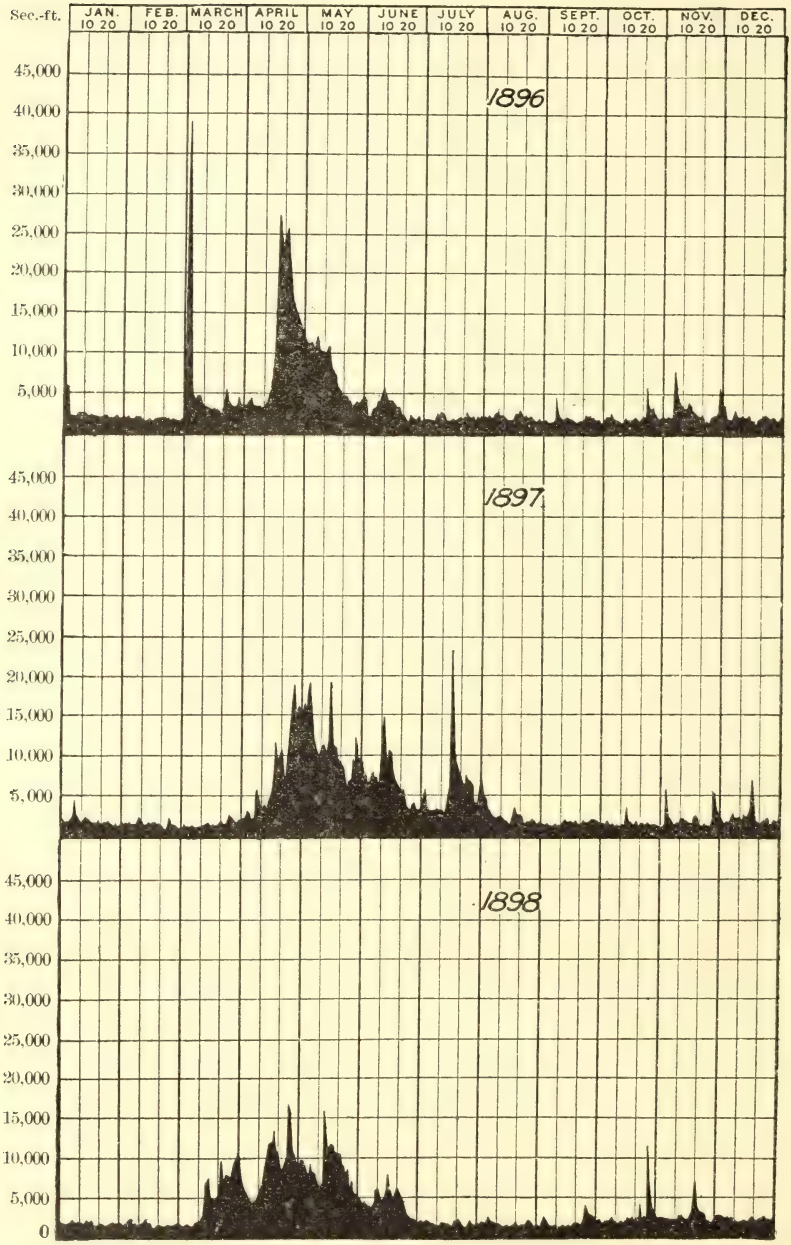


FIG. 10.—Discharge of Androscoggin River at Rumford Falls, Me., 1896 to 1898.

Estimated monthly discharge of Androscoggin River at Rumford Falls, Me.—Continued.

Month.	Discharge in second-feet.			Run-off.		Rainfall in inches.
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.	
1899.						
January	2,675	1,697	2,111	0.91	1.05	3.18
February	2,111	1,462	1,843	0.79	0.82	2.56
March	2,037	1,646	1,848	0.80	0.92	5.89
April	23,287	1,974	8,709	3.75	4.18	1.50
May	24,077	3,849	10,114	4.36	5.03	1.89
June	3,773	2,717	3,238	1.40	1.56	2.27
July	3,682	1,142	1,817	0.78	0.90	4.71
August	1,758	1,209	1,428	0.62	0.71	0.64
September	2,971	1,124	1,580	0.68	0.76	3.00
October	2,767	1,230	1,604	0.69	0.80	2.05
November	3,172	1,170	1,733	0.75	0.84	1.94
December	5,274	1,010	1,606	0.69	0.80	1.95
The year	24,077	1,010	3,136	1.35	18.37	31.58

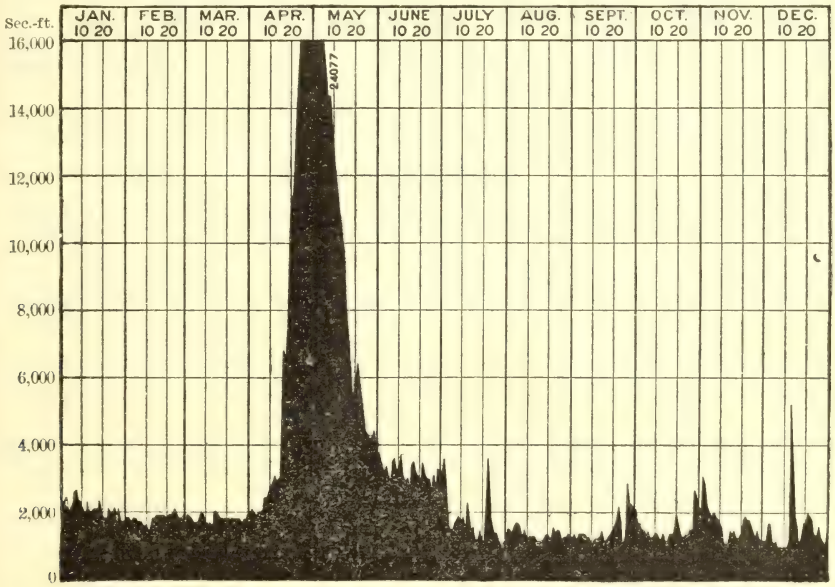


FIG. 11.—Discharge of Androscoggin River at Rumford Falls, Me., 1899.

Estimated monthly discharge of Androscoggin River at Rumford Falls, Me.—Continued

Month.	Discharge in second-feet.			Run-off.		Rainfall, in inches.
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.	
1900.						
January	3,221	1,115	1,408	0.61	0.70	5.80
February	6,009	1,277	2,555	1.10	1.15	7.96
March	5,063	1,600	2,109	0.91	1.05	5.82
April	22,025	1,830	9,763	4.21	4.69	1.21
May	24,531	6,632	12,633	5.45	6.28	4.57
June	7,458	1,810	4,127	1.78	1.99	3.35
July	3,168	1,640	2,201	0.95	1.10	4.25
August	2,009	1,318	1,574	0.68	0.78	2.42
September	2,025	1,247	1,596	0.69	0.77	2.31
October	3,754	1,430	2,213	0.95	1.10	3.91
November	12,061	1,460	3,945	1.70	1.90	7.22
December	3,264	1,764	2,331	1.00	1.15	1.15
The year	24,531	1,115	3,871	1.67	22.66	50.07
1901.						
January	2,082	1,692	1,895	0.82	0.95	2.77
February	2,496	1,563	1,832	0.79	0.82	0.74
March	4,445	1,873	2,463	1.06	1.22	4.05
April	32,653	2,887	14,891	6.42	7.16	7.91
May	16,808	6,285	10,714	4.62	5.33	6.54
June	7,424	2,787	4,420	1.91	2.13	3.84
July	3,833	1,612	2,671	1.15	1.33	4.91
August	5,035	1,925	2,820	1.22	1.41	3.47
September	1,955	1,343	1,590	0.69	0.77	2.59
October	5,137	1,547	2,224	0.96	1.11	3.48
November	1,829	1,205	1,606	0.69	0.77	1.76
December	27,785	1,209	3,764	1.62	1.87	5.53
The year	32,653	1,205	4,241	1.83	24.87	47.59

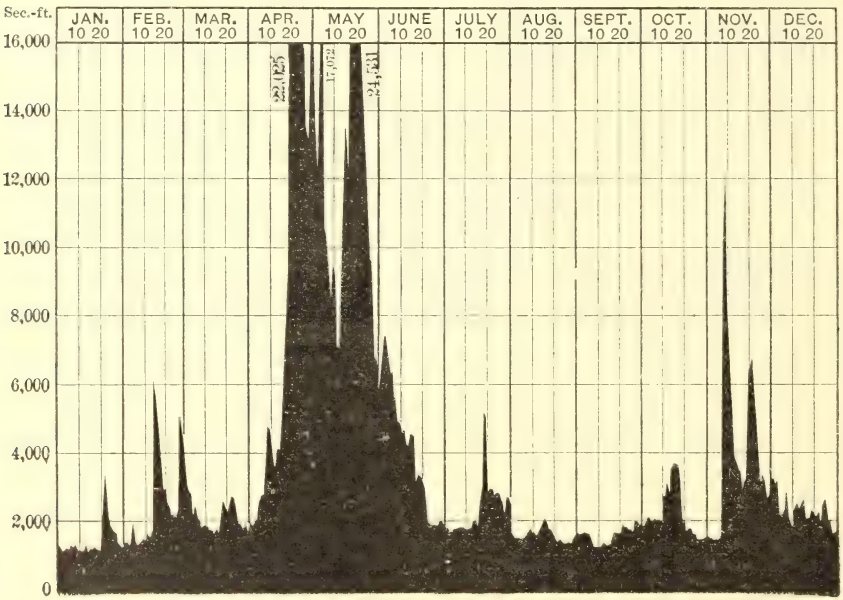


FIG. 12.—Discharge of Androscoggin River at Rumford Falls, Me., 1900.

Run-off, in second-feet per square mile, of Androscoggin River at Rumford Falls, Me.

[Drainage area, 2,320 square miles.]

Month.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.	1901.	Average.
January	.....	1.37	1.17	0.78	1.26	0.78	0.84	0.91	0.61	0.82	0.95
February	.....	1.29	0.84	0.54	0.75	0.73	0.73	0.79	1.10	0.79	0.84
March	.....	1.38	1.74	0.53	2.35	0.78	2.22	0.80	0.91	1.06	1.31
April	.....	2.17	4.08	5.17	5.36	3.41	4.01	3.75	4.21	6.42	4.29
May	3.30	7.45	3.55	3.29	3.25	5.01	3.89	4.36	5.45	4.62	4.42
June	3.19	2.47	2.20	1.24	1.34	3.02	2.04	1.40	1.78	1.91	2.06
July	3.33	1.24	1.08	0.77	0.86	2.85	0.81	0.78	0.95	1.15	1.38
August	2.09	1.42	0.83	0.78	0.83	1.01	0.73	0.62	0.68	1.22	1.02
September	1.74	1.16	0.96	0.86	0.83	0.69	0.84	0.68	0.69	0.69	0.91
October	1.20	1.69	1.08	1.16	0.91	0.69	1.22	0.69	0.95	0.96	1.05
November	2.47	1.31	1.31	1.54	1.32	0.98	1.18	0.75	1.70	0.69	1.33
December	1.38	1.13	0.90	1.80	0.87	1.12	0.94	0.69	1.00	1.62	1.14
The year	.....	2.01	1.65	1.54	1.66	1.76	1.62	1.35	1.67	1.83	1.70

LITTLE ANDROSCOGGIN RIVER.

Little Androscoggin River enters the main stream at Auburn. Rising in Oxford County, it has a total length of 30 miles and a drainage basin of 380 square miles. In this area there are 21 small ponds, with an aggregate area of about 22 square miles. Dams have been constructed at the outlets of a number of these ponds, so that the flow of the stream is rather constant, making it particularly valuable for water-power development. In the first three-fourths of a mile above its mouth the river has a fall of 70 feet. At the two dams nearest its mouth the power is owned by the Little Androscoggin Water Power Company, and is leased to the users. At the lower dam are the Barker Woolen Mills, having 35 feet of fall, with 400 horsepower of wheels, and several small woodworking and other establishments, using in the aggregate about 250 horsepower. The fall at the upper dam is 26 feet, and the power is used by the Auburn and Lewiston Electric Light Company. The privilege is regarded as good for 300 horsepower at all times. The electric-light company also leases the power at the third dam, where it has installed two 310-horsepower turbines, which work under a fall of about 23 feet.

At Mechanic Falls, 10 miles above the mouth of the river, the Poland Paper Company uses 30 feet fall and has turbines rated at 1,200 horsepower, while at the succeeding privilege a dam was built in August, 1896, to develop power for the Mechanic Falls Electric Light and Power Company. Above this point there is but little power used.

PRESUMPSCOT RIVER.

This is one of the most interesting as well as one of the best water-power streams of its size in the United States. It is the outlet of Sebago Lake, which lies about 17 miles northwest of Portland. (See Pl. X.) The lake is fed by Crooked River, a stream heading 35 miles farther north and within 3 miles of the Androscoggin. The area of

the lake is 50 square miles, the area of its drainage basin at the outlet of the lake 470 square miles, and the total drainage area of the river at its mouth 700 square miles. The northern part of the basin is mountainous and wooded, while the southern part is moderately hilly and cleared of trees. Granite, gneiss, and mica-schists appear at many points, and the soil is gravelly and sandy.

According to the survey made by Mr. Joseph A. Warren, of Cumberland Mills, the fall from the crest of the stone dam at the foot of Sebago Lake to mean low tide at the foot of the lower falls is 265.16 feet in a distance of 21.65 miles, or an average of 12.25 feet a mile. In the lower two-thirds of this distance, or from Gambo Falls to tide water, nearly seven-eighths of the whole fall, or 132 feet, has been improved, and an aggregate probably exceeding 6,000 net horsepower is in use. The remainder of the fall, however, between Gambo Falls and Sebago Lake, amounting to 133 feet, is either unimproved or but slightly utilized. At Great Falls, in this stretch, there is a descent of 22 feet, which has been used in the past but is now idle. It is proposed, however, to employ the power in the generation of electricity for delivery in Portland.

By far the largest users of power on the river are Messrs. S. D. Warren & Company, paper manufacturers, at whose plant at Cumberland Mills about 3,000 horsepower is used from all sources. Of this, 1,500 horsepower is from water direct, a fall of 20 feet being utilized, and the remainder is from steam and electricity, the latter being transmitted from the lower falls, 6 miles downstream, where there is a dam giving a fall, varying with the tide, of from 11 to 21 feet.

The next power above Cumberland Mills is at Saccarappa, where there are two dams giving falls of 19 and 12 feet, respectively. Here are the cotton mills of the Westbrook Manufacturing Company and the Dana Warp Company, the power house of the Westbrook Electric Light and Power Company, and several other smaller mills, the total water power used by all the establishments when in full operation being about 1,900 horsepower. At Mallison Falls about 300 horsepower, under a head of 20 feet, is used at the woolen mill of the Robinson Manufacturing Company, and at Little Falls 1,600 horsepower, with a head of 18 feet, is employed by the Sebago Wood Board Company.

The tributaries of Presumpscot River are not of much importance, but some of them are outlets of ponds and have considerable fall, thus affording constant though small power. Crooked River, the chief feeder of Sebago Lake, has a number of falls, some of which are utilized.

The chief interest attaching to the river is its regularity of flow, which is due to dams at the outlet of the lake. Nowhere in the United States is there a better example of the success of storage of

water and regulation of the flow of a stream than on the Presumpscot. Since January, 1887, the flow from Sebago Lake has been regularly recorded, the quantity being deduced from the openings in the gates at the dam, the discharging capacity of which under different conditions of head has been determined and tabulated by Mr. Hiram F. Mills, of Lowell. Since January, 1872, a continuous record of the level of the lake surface has been kept. An unusually complete and valuable series of data has thus been obtained, which has been furnished to the United States Geological Survey by Messrs. S. D. Warren & Company. The lake fills rapidly after the first of March, attaining its maximum height between the middle of April and the first of June, and then gradually subsides as water is withdrawn for mill purposes, until a minimum stage is reached, sometimes in the autumn, but usually in the winter. The following records of the daily discharge of the river at the outlet of the lake show the remarkable uniformity of flow, which, as already stated, is due largely to artificial regulation. There is no other river in the United States upon which so small variations occur throughout the year. On Sundays the gates are closed, so that only the waste is allowed to reach the river.

Daily discharge, in second-feet, of Presumpscot River at the outlet of Sebago Lake.

[Drainage area, 470 square miles.]

1887.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	933	933	933	933	(a)	1,000	933	837	933	933	933	933
2	(a)	933	933	933	933	1,000	933	837	933	(a)	933	933
3	933	933	933	(a)	933	1,000	(a)	837	933	933	933	933
4	933	933	933	933	933	1,000	933	837	(a)	933	933	(a)
5	933	933	933	933	933	1,000	933	837	933	933	933	933
6	933	(a)	(a)	933	933	1,000	933	837	933	933	(a)	933
7	933	933	933	933	933	1,000	896	(a)	933	933	933	933
8	933	933	933	933	(a)	1,000	896	837	933	933	933	933
9	(a)	933	933	933	933	1,000	896	837	933	(a)	933	933
10	933	933	933	(a)	933	1,000	(a)	837	933	933	933	933
11	933	933	850	933	933	1,000	896	974	(a)	933	933	(a)
12	933	933	850	933	1,000	1,000	896	974	933	933	933	933
13	933	(a)	(a)	933	1,000	1,000	896	974	933	933	(a)	933
14	860	933	850	933	1,000	1,000	933	(a)	933	933	933	933
15	860	933	950	933	1,000	1,000	933	974	933	933	933	964
16	(a)	933	850	933	1,000	1,000	933	974	933	(a)	933	964
17	860	933	850	(a)	1,000	1,000	(a)	974	933	933	933	964
18	860	933	1,003	933	1,000	1,000	933	974	(a)	933	933	(a)
19	860	933	1,003	933	1,000	1,000	933	862	933	933	933	964
20	860	(a)	(a)	933	1,000	1,000	933	862	933	933	(a)	964
21	860	933	933	933	1,000	1,000	878	(a)	933	933	933	964
22	860	933	933	933	1,000	1,000	878	862	933	933	933	964
23	(a)	933	933	933	1,000	908	878	862	933	(a)	933	964
24	860	933	933	(a)	1,000	908	(a)	862	933	933	933	964
25	860	933	933	933	1,000	908	878	933	(a)	933	933	(a)
26	860	933	933	933	1,000	(a)	878	933	933	933	933	964
27	933	(a)	(a)	933	1,000	908	878	933	933	933	(a)	964
28	933	933	933	933	1,000	908	837	(a)	933	933	933	964
29	933	.....	933	933	1,000	908	837	933	933	933	933	964
30	(a)	.....	933	933	1,000	933	837	933	933	(a)	933	964
31	933	.....	933	.....	1,000	.....	(a)	933	.....	933	.....	964
Mean	902	933	920	933	979	978	901	898	933	933	933	950

[a] Sunday; gates closed.

Daily discharge, in second-feet, of Presumpscot River, etc.—Continued.

1888.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	(a)	964	919	(a)	933	1,667	(a)	852	825	818	695	933
2	964	857	919	866	933	1,667	933	850	(a)	818	695	(a)
3	964	857	919	866	933	1,667	933	850	825	818	695	933
4	964	857	(a)	866	933	1,667	933	850	825	811	(a)	933
5	974	(a)	919	866	933	1,667	933	(a)	825	811	695	933
6	974	857	919	866	(a)	1,667	933	850	825	811	695	933
7	974	857	919	866	933	1,000	933	850	825	(a)	695	933
8	(a)	857	919	(a)	933	1,000	(a)	850	825	811	833	933
9	974	857	919	866	933	1,000	933	840	(a)	811	833	(a)
10	974	857	919	866	933	1,000	933	840	825	717	833	933
11	974	857	(a)	866	933	1,000	933	840	825	717	(a)	933
12	974	(a)	919	933	933	1,000	869	(a)	933	717	833	933
13	974	857	919	933	(a)	1,000	869	840	933	717	833	933
14	974	857	919	933	933	1,000	869	840	933	(a)	833	933
15	(a)	857	960	(a)	1,667	1,000	(a)	833	933	717	833	933
16	974	857	960	933	1,667	1,000	869	833	(a)	717	833	(a)
17	974	857	960	933	1,667	1,000	869	833	933	717	833	933
18	974	857	(a)	933	1,667	1,000	869	833	933	717	(a)	933
19	964	(a)	960	933	1,667	1,000	852	(a)	933	717	833	1,000
20	964	857	960	933	1,667	1,000	852	833	925	717	833	1,000
21	964	857	960	933	1,667	933	852	833	925	(a)	833	1,000
22	(a)	857	866	(a)	1,667	933	(a)	825	925	717	917	1,000
23	964	857	866	933	1,667	933	852	825	(a)	717	917	(a)
24	964	857	866	933	1,667	(a)	852	825	925	717	917	1,000
25	964	857	(a)	933	1,667	933	852	825	925	695	(a)	1,000
26	964	(a)	866	933	1,667	933	852	(a)	925	695	917	933
27	964	857	866	933	1,667	933	852	825	818	695	917	933
28	964	857	866	933	1,667	933	852	825	818	(a)	933	933
29	(a)	857	866	(a)	1,667	933	(a)	825	818	695	933	933
30	964	.....	866	933	1,667	933	852	825	(a)	695	933	(a)
31	964	.....	866	.....	1,667	.....	852	825	.....	695	.....	933
Mean	969	861	910	909	1,363	1,117	884	836	878	741	829	948

1889.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	933	933	1,000	1,000	1,000	933	933	933	(a)	850	894	(a)
2	933	933	1,000	1,000	1,000	933	933	933	866	850	894	858
3	933	933	1,000	1,000	1,000	933	933	933	866	850	(a)	858
4	933	933	1,000	1,000	1,000	933	933	(a)	866	835	894	858
5	933	933	1,000	1,000	1,000	933	933	933	866	835	894	858
6	(a)	933	1,000	1,000	1,000	933	933	933	850	(a)	894	858
7	933	1,000	1,000	1,000	1,000	933	(a)	933	850	835	894	858
8	933	1,000	1,000	1,000	1,000	933	933	933	(a)	835	894	(a)
9	933	1,000	1,000	1,000	1,000	933	933	933	850	835	894	858
10	933	1,000	1,000	1,000	1,000	933	933	933	850	883	(a)	858
11	933	1,000	1,000	1,000	1,000	933	933	(a)	850	883	894	858
12	933	1,000	1,000	1,000	1,000	933	933	933	850	883	894	858
13	(a)	1,000	1,000	1,000	1,000	933	933	933	850	(a)	894	749
14	933	1,000	1,033	1,000	1,000	933	(a)	933	850	883	894	749
15	933	1,000	1,033	1,000	1,000	933	933	933	(a)	883	894	(a)
16	933	1,000	1,033	1,000	1,000	933	933	933	850	883	894	749
17	933	1,000	1,033	1,000	1,000	933	933	933	850	830	(a)	749
18	933	1,000	1,033	1,000	1,000	933	933	(a)	850	830	894	749
19	933	1,000	1,033	1,000	1,000	933	933	933	850	830	894	749
20	(a)	1,000	1,033	1,000	1,000	933	933	933	850	(a)	894	950
21	933	1,000	1,414	1,000	1,000	933	(a)	933	850	830	865	950
22	933	1,000	1,414	1,000	1,000	933	933	904	(a)	830	865	(a)
23	1,000	1,000	1,414	1,000	1,000	933	933	904	850	830	865	950
24	1,000	1,000	1,414	1,000	1,000	933	933	904	850	830	(a)	950
25	1,000	1,000	1,414	1,000	1,000	933	933	.....	850	830	865	950
26	1,000	1,000	1,414	1,000	1,000	933	933	904	850	830	865	967
27	1,000	1,000	1,414	1,000	1,000	933	933	904	850	(a)	865	967
28	1,000	1,000	1,000	1,000	1,000	933	(a)	904	850	830	865	967
29	1,000	.....	1,000	1,000	1,000	933	933	866	(a)	830	858	(a)
30	1,000	.....	1,000	1,000	933	(a)	933	866	850	830	858	967
31	933	.....	1,000	.....	933	.....	933	866	.....	894	.....	967
Mean	952	985	1,101	1,000	996	933	933	919	853	847	883	872

a Sunday; gates closed.

Daily discharge, in second-feet, of Presumpscot River, etc.—Continued.

1890.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	967	982	982	904	1,336	(a)	957	904	873	881	898	965
2	967	(a)	(a)	904	1,336	1,262	957	904	873	881	(a)	965
3	967	982	982	904	1,336	884	957	(a)	873	973	898	965
4	967	982	982	904	1,336	884	957	904	866	973	898	965
5	(a)	982	982	904	1,336	884	957	904	866	(a)	898	965
6	967	973	991	(a)	1,336	1,059	(a)	904	866	973	973	965
7	967	973	991	904	1,336	1,059	957	896	(a)	973	973	(a)
8	967	973	991	904	1,336	(a)	957	896	866	973	973	965
9	967	(a)	(a)	904	1,336	1,059	957	896	866	973	(a)	965
10	967	973	991	919	1,336	1,059	957	(a)	866	1,063	973	965
11	967	973	901	919	1,336	1,059	957	896	858	1,063	973	956
12	(a)	973	991	919	1,336	957	957	896	858	(a)	973	956
13	967	973	889	(a)	1,336	957	(a)	896	858	1,063	965	956
14	967	982	889	919	1,336	957	957	896	(a)	1,063	965	(a)
15	967	982	889	919	1,336	(a)	957	896	858	1,063	965	956
16	881	(a)	(a)	919	1,336	957	957	896	858	956	(a)	956
17	881	982	889	1,336	1,336	957	425	(a)	858	956	965	956
18	881	982	889	1,336	1,336	957	425	896	873	956	965	1,046
19	(a)	982	889	1,336	1,336	957	425	896	873	(a)	965	1,046
20	881	982	896	1,336	1,336	957	(a)	896	873	956	973	1,046
21	881	982	896	1,336	1,336	957	425	733	(a)	956	973	(a)
22	881	982	896	1,336	1,336	(a)	425	733	873	956	973	1,046
23	881	(a)	(a)	1,336	1,336	957	425	733	873	898	(a)	1,046
24	881	982	896	1,336	1,336	957	800	(a)	873	898	973	1,046
25	881	982	896	1,336	1,336	957	800	733	881	898	973	1,046
26	(a)	982	896	1,336	1,336	957	800	733	881	(a)	973	1,034
27	881	982	904	1,336	1,336	957	(a)	733	881	898	965	1,034
28	881	982	904	1,336	1,262	957	800	873	(a)	898	965	(a)
29	881	.....	904	1,336	1,262	(a)	800	873	881	898	965	1,034
30	982	.....	(a)	1,336	1,262	957	800	873	881	898	(a)	1,034
31	982	.....	904	.....	1,262	.....	904	(a)	.....	898	.....	1,034
Mean	930	979	931	1,123	1,326	981	802	857	869	957	958	994

1891.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1,034	(a)	(a)	1,670	1,670	1,008	991	947	916	877	(a)	793
2	1,034	956	965	1,670	1,670	1,008	973	(a)	916	877	922	793
3	1,034	956	965	1,670	1,670	1,008	973	947	916	877	922	793
4	(a)	956	965	1,670	1,670	800	973	947	916	(a)	922	793
5	1,034	956	973	(a)	1,414	800	(a)	947	916	852	922	793
6	1,034	956	973	1,670	1,414	800	973	966	(a)	852	922	(a)
7	1,034	956	973	1,670	1,149	(a)	973	966	916	852	922	767
8	929	(a)	(a)	1,670	1,149	1,008	973	966	916	852	(a)	767
9	929	956	973	1,670	1,149	1,008	672	(a)	916	852	875	767
10	929	956	973	1,670	.....	1,008	872	966	916	852	875	767
11	(a)	965	973	1,670	1,017	999	672	966	916	(a)	875	767
12	977	965	973	(a)	1,017	999	(a)	966	916	966	875	767
13	977	965	973	1,670	1,017	999	672	690	(a)	966	875	(a)
14	977	965	973	1,670	1,017	(a)	672	690	906	966	875	741
15	977	(a)	(a)	1,670	1,017	999	672	690	906	966	(a)	741
16	977	965	973	1,670	1,017	999	973	(a)	906	966	875	741
17	977	965	973	1,670	(a)	999	973	690	906	966	875	741
18	(a)	965	973	1,670	1,017	991	973	690	906	(a)	875	741
19	977	961	973	(a)	1,017	991	(a)	690	906	924	875	741
20	977	961	991	1,670	1,017	991	853	933	(a)	924	875	(a)
21	977	961	991	1,670	1,008	(a)	853	933	887	924	975	741
22	977	(a)	(a)	1,670	1,008	991	853	933	887	924	(a)	741
23	977	961	991	1,670	1,008	991	717	(a)	887	924	806	741
24	977	961	991	1,670	(a)	991	717	911	887	924	806	741
25	(a)	961	514	1,670	1,008	991	717	911	887	(a)	806	741
26	977	965	514	(a)	1,008	991	(a)	911	887	922	806	741
27	977	965	514	1,670	1,008	991	717	911	(a)	922	806	(a)
28	956	965	514	1,670	1,008	(a)	717	911	877	922	806	754
29	956	.....	(a)	1,670	1,008	991	717	911	877	922	(a)	754
30	956	.....	1,670	1,670	1,008	991	947	(a)	877	922	793	754
31	956	.....	1,670	.....	(a)	.....	947	916	.....	922	.....	754
Mean	981	961	958	1,670	1,155	975	835	881	902	912	866	758

[a] Sunday; gates closed.

Daily discharge, in second-feet, of Presumpscot River, etc.—Continued.

1892.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	754	855	793	741	(a)	724	595	819	833	667	582	583
2	754	855	793	741	722	724	595	819	833	(a)	582	583
3	(a)	855	793	(a)	722	724	(a)	819	833	633	582	583
4	638	855	793	741	722	724	595	819	(a)	633	582	(a)
5	638	855	793	741	722	(a)	595	819	800	633	582	573
6	638	855	(a)	741	722	724	595	819	800	633	(a)	573
7	638	(a)	780	741	722	724	595	(a)	800	633	582	573
8	638	806	780	741	(a)	724	595	806	800	633	582	573
9	638	806	780	741	709	724	595	806	800	(a)	582	573
10	(a)	806	780	(a)	709	724	(a)	806	800	600	582	573
11	819	806	780	617	709	724	867	806	(a)	600	582	(a)
12	819	806	780	617	709	(a)	867	806	750	600	582	583
13	819	806	(a)	617	709	793	867	806	750	600	(a)	583
14	819	(a)	767	617	709	793	867	(a)	750	600	521	583
15	819	806	767	617	(a)	793	867	831	750	600	521	583
16	819	806	767	617	754	793	867	831	750	(a)	521	583
17	(a)	806	767	(a)	754	793	(a)	831	750	600	521	583
18	867	806	767	806	754	793	896	831	(a)	600	521	(a)
19	867	806	767	806	754	(a)	896	831	700	600	521	583
20	867	806	(a)	806	754	750	896	831	700	600	(a)	583
21	867	(a)	754	806	754	750	896	(a)	700	600	601	583
22	867	780	754	806	(a)	750	896	875	700	600	601	583
23	868	780	754	806	724	750	896	875	700	(a)	601	583
24	(a)	780	754	(a)	724	750	(a)	875	700	582	601	583
25	855	780	754	722	724	750	892	875	(a)	582	601	(a)
26	855	780	754	722	724	(a)	892	875	667	582	601	567
27	855	780	(a)	722	724	595	892	875	667	582	(a)	567
28	855	(a)	741	722	725	595	892	(a)	667	582	583	567
29	855	793	741	722	(a)	595	892	833	667	582	583	567
30	855	.....	741	722	724	595	892	833	667	(a)	583	567
31	(a)	.....	741	.....	724	.....	(a)	833	.....	582	.....	567
Mean	792	811	768	723	727	726	796	833	744	605	572	577

1893.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	167	558	601	442	733	900	833	750	750	767	650	600
2	600	558	601	167	733	900	167	750	750	783	650	600
3	600	558	601	590	733	900	750	775	167	783	650	200
4	600	558	601	590	733	167	750	775	767	783	650	833
5	600	167	167	590	733	900	750	775	767	783	167	833
6	600	592	610	590	733	900	750	167	767	783	750	833
7	600	592	610	590	167	900	750	767	767	783	750	833
8	167	592	610	590	533	900	750	767	767	133	750	833
9	592	592	610	167	533	900	167	767	767	800	750	833
10	592	592	610	517	533	900	733	767	167	800	750	200
11	592	592	610	517	533	.....	733	167	767	800	750	867
12	592	167	167	517	533	783	733	167	767	800	167	833
13	592	600	612	517	533	783	733	167	767	800	733	833
14	592	600	612	517	167	783	733	750	767	800	733	833
15	167	600	612	517	433	783	733	750	767	.....	733	833
16	582	600	612	167	433	783	167	750	767	750	733	833
17	582	600	612	575	433	783	800	750	767	750	733	200
18	582	600	612	575	433	.....	800	750	767	750	733	833
19	582	167	167	575	433	733	800	750	767	750	433	833
20	582	600	533	575	433	733	800	167	767	750	800	833
21	582	600	533	575	.....	733	800	742	767	750	800	833
22	167	600	533	575	833	733	800	742	767	750	800	833
23	558	600	533	167	833	733	167	742	767	750	550	833
24	558	600	533	708	833	733	833	742	767	750	550	200
25	558	600	533	708	833	.....	833	742	783	750	550	833
26	558	167	167	708	833	833	833	742	783	417	183	833
27	558	601	442	708	833	833	833	167	783	417	833	833
28	558	601	442	708	.....	833	833	750	783	417	833	833
29	167	.....	442	708	900	833	833	750	783	167	833	833
30	558	.....	442	167	900	833	167	750	783	650	600	833
31	558	.....	442	.....	900	.....	700	750	.....	650	.....	200
Mean	514	520	510	521	628	797	679	640	729	687	650	717

(a) Sunday; gates closed.

Daily discharge, in second-feet, of Presumpscot River, etc.—Continued.

1894.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	833	800	667	167	667	450	167	717	567	550	542	533
2	833	800	667	458	800	450	800	717	167	550	542	533
3	833	800	667	458	800	167	800	717	558	550	542	533
4	833	167	(a)	458	800	600	222	717	558	550	133	533
5	833	667	682	500	800	600	133	167	558	550	533	533
6	833	667	682	500	133	700	133	717	558	550	533	533
7	208	667	682	500	800	700	133	717	558	133	533	533
8	833	667	682	167	800	700	133	717	558	550	533	533
9	833	667	682	382	800	700	783	717	167	550	533	133
10	833	667	682	382	800	167	783	717	558	550	533	767
11	833	167	(a)	382	800	758	783	717	558	550	133	767
12	833	667	525	382	800	758	783	100	558	550	542	767
13	833	667	525	382	133	758	783	667	558	550	542	767
14	208	667	525	517	800	758	783	667	558	133	542	767
15	833	667	525	167	800	758	167	667	558	542	542	767
16	833	667	525	500	800	758	817	667	133	542	542	133
17	833	667	525	500	800	167	817	667	567	542	542	767
18	833	167	(a)	500	800	758	817	667	567	542	133	767
19	833	667	533	500	800	758	817	100	567	542	542	767
20	833	667	533	500	133	758	817	667	567	542	542	767
21	208	667	533	500	582	758	817	667	567	133	542	767
22	833	667	533	167	582	758	167	667	567	542	542	767
23	883	667	533	675	582	758	800	667	133	542	542	133
24	833	667	533	675	582	167	800	667	558	542	542	758
25	833	667	(a)	675	582	800	800	667	558	542	133	758
26	833	667	550	675	582	800	800	333	558	542	533	758
27	833	667	550	675	133	800	800	667	558	542	533	758
28	208	667	550	675	450	800	800	667	558	133	533	758
29	800	.....	550	133	450	800	167	667	558	542	533	758
30	800	.....	550	667	450	800	717	567	133	542	533	133
31	800	.....	550	.....	450	.....	717	567	.....	542	.....	758
Mean	749	628	583	461	622	649	608	613	491	492	484	610

1895.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	758	700	667	667	783	700	675	533	133	550	617	250
2	758	700	667	667	700	167	675	533	600	550	617	500
3	758	133	133	667	700	700	675	533	600	550	208	500
4	758	750	667	500	700	700	167	400	600	550	617	500
5	758	750	667	500	167	700	167	600	600	550	617	500
6	133	750	667	500	700	700	167	600	600	133	617	500
7	758	750	667	167	700	700	167	600	600	533	617	500
8	758	750	667	400	700	700	667	600	133	533	617	125
9	758	750	667	400	700	167	667	600	583	533	617	500
10	758	133	133	400	700	693	667	600	583	533	208	500
11	758	700	667	400	700	693	667	133	583	533	617	500
12	758	700	667	400	167	693	667	533	583	533	617	500
13	133	700	667	400	700	693	667	533	583	133	617	500
14	742	700	667	133	700	693	133	533	583	267	617	500
15	742	700	667	333	700	693	667	533	133	267	617	250
16	742	700	667	333	700	167	667	533	575	400	617	500
17	742	133	.....	333	700	683	667	533	575	533	104	500
18	742	700	667	667	700	683	667	133	575	533	417	500
19	742	700	667	667	167	683	667	550	575	533	417	500
20	133	700	667	667	700	683	667	550	575	267	417	500
21	750	700	667	167	700	683	133	550	575	500	417	500
22	750	700	667	667	700	683	567	550	133	500	217	250
23	750	700	667	667	700	167	567	550	567	500	217	417
24	750	133	.....	667	700	675	567	550	567	500	217	417
25	750	667	667	783	700	675	567	133	567	500	483	417
26	750	667	667	783	167	675	567	517	567	500	483	333
27	133	667	667	783	700	675	567	517	567	250	483	333
28	700	667	500	167	700	675	133	517	567	617	483	333
29	700	.....	500	783	700	675	533	600	133	617	250	200
30	700	.....	500	783	700	167	533	600	550	617	250	533
31	700	.....	167	.....	700	.....	533	600	.....	617	.....	533
Mean	665	625	596	512	634	601	519	511	505	475	464	432

[a] Sunday; gates closed.

Daily discharge, in second-feet, of Presumpscot River, etc.—Continued.

1896.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	533	533	133	450	1,167	933	950	817	817	800	100	800
2	267	267	300	450	1,167	933	950	117	817	800	800	800
3	267	533	617	450	1,167	933	950	808	817	800	800	800
4	267	533	617	450	883	883	467	808	817	100	800	800
5	250	533	.....	.....	883	883	133	808	817	800	800	800
6	533	533	.....	667	883	883	950	808	117	800	800	100
7	533	533	.....	667	883	100	950	808	725	800	633	800
8	533	400	.....	667	767	933	950	808	725	800	100	800
9	533	133	633	667	767	933	950	117	725	800	800	800
10	533	547	633	467	167	933	950	800	725	800	800	800
11	533	547	633	467	883	933	950	800	725	100	800	800
12	267	547	633	118	883	933	133	800	725	800	800	800
13	533	547	633	467	883	933	933	800	100	400	633	100
14	533	547	633	467	883	100	933	800	833	633	633	833
15	533	547	.....	600	883	917	933	800	833	633	100	833
16	533	137	633	600	883	917	933	117	833	633	800	833
17	533	547	633	333	167	917	933	800	200	633	800	833
18	533	547	633	333	917	917	933	800	200	100	800	833
19	267	547	633	133	917	917	133	800	.....	633	800	833
20	533	547	317	900	917	917	800	800	100	633	800	100
21	533	547	158	900	883	100	800	800	817	633	800	817
22	533	547	.....	900	883	917	800	800	817	633	100	817
23	533	137	500	900	883	917	800	100	817	633	800	817
24	533	533	500	900	133	917	800	833	817	800	800	817
25	533	533	500	900	933	917	800	833	817	100	800	817
26	267	533	500	900	933	950	117	833	817	800	800	100
27	533	533	500	1,167	933	950	767	833	100	800	800	817
28	533	533	500	1,167	933	133	767	833	800	800	800	817
29	533	533	.....	1,167	933	950	817	783	800	800	100	817
30	533	.....	450	1,167	117	950	817	100	800	633	800	817
31	533	.....	450	.....	117	.....	817	817	.....	633	.....	817
Mean	472	484	515	670	795	815	771	696	657	638	667	7[illegible]

1897.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	817	817	833	542	667	817	833	(a)	950	775	833	917
2	817	817	833	542	(a)	817	833	1,433	950	775	833	917
3	(a)	817	833	542	600	817	833	1,433	950	(a)	833	917
4	700	817	833	(a)	600	817	(a)	1,433	950	933	833	917
5	700	817	833	367	600	817	250	1,433	(a)	933	833	(a)
6	700	817	833	367	600	(a)	250	1,433	933	933	833	917
7	700	(a)	(a)	367	600	617	250	1,433	933	933	(a)	917
8	700	817	833	367	600	617	250	(a)	933	933	700	917
9	700	817	833	367	(a)	617	250	1,000	933	933	700	917
10	(a)	817	833	367	617	617	250	1,000	933	(a)	700	917
11	817	817	833	(a)	617	617	(a)	1,000	933	933	700	917
12	817	817	833	383	617	617	900	1,000	(a)	933	700	(a)
13	817	817	833	383	617	(a)	900	1,000	933	933	700	867
14	817	(a)	(a)	383	617	800	900	1,000	933	933	(a)	867
15	817	758	800	383	617	800	900	(a)	933	933	833	867
16	817	758	800	383	(a)	806	900	883	933	933	833	867
17	(a)	758	800	383	650	800	900	883	933	(a)	833	867
18	817	758	800	(a)	650	800	(a)	883	933	967	833	867
19	817	758	800	567	650	800	1,033	883	(a)	967	833	(a)
20	817	758	800	567	650	(a)	1,033	883	917	967	833	933
21	817	(a)	(a)	567	650	833	1,033	883	917	967	(a)	933
22	817	833	667	567	650	833	1,033	(a)	917	967	867	933
23	817	833	667	567	(a)	833	1,033	917	917	967	867	933
24	(a)	833	667	567	742	833	1,033	917	917	(a)	867	933
25	817	833	667	(a)	742	833	(a)	917	917	1,000	867	933
26	817	833	667	667	742	833	1,200	917	(a)	1,000	867	(a)
27	817	833	667	667	742	(a)	1,200	917	775	1,000	867	933
28	817	(a)	(a)	667	742	833	1,200	917	775	1,000	(a)	933
29	817	.....	542	667	742	833	1,200	(a)	775	1,000	917	933
30	817	.....	542	667	(a)	833	1,200	950	775	1,000	917	933
31	(a)	.....	542	.....	817	.....	1,200	950	.....	(a)	.....	933
Mean	790	806	756	495	659	772	844	1,050	908	944	817	912

(a) Sunday; gates closed.

Daily discharge, in second-feet, of Presumpscot River, etc.—Continued.

1898.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	933	933	933	800	2,000	1,000	993	1,000	1,000	967	800	600
2	333	933	933	800	2,000	1,000	993	1,000	1,000	233	800	600
3	933	933	933	267	2,000	1,000	250	1,000	1,000	1,000	800	600
4	933	933	933	900	2,000	1,000	1,053	1,000	250	1,000	800	300
5	933	933	933	900	2,000	333	1,053	1,000	1,000	1,000	800	800
6	933	667	667	900	2,000	1,000	1,053	1,000	1,000	1,000	200	800
7	933	933	933	900	2,000	1,000	1,053	250	1,000	1,000	800	800
8	933	933	933	900	1,000	1,000	1,053	1,000	1,000	1,000	800	800
9	333	933	933	900	1,000	1,000	1,053	1,000	1,000	250	800	800
10	933	933	933	833	1,000	1,000	250	1,000	1,000	983	800	800
11	933	933	933	867	1,000	1,000	1,000	1,000	250	983	800	300
12	933	933	933	867	1,000	417	1,000	1,000	968	983	800	783
13	933	667	667	867	1,000	1,000	1,000	1,000	967	983	200	783
14	933	933	933	867	1,000	1,000	1,000	250	967	983	800	783
15	933	933	933	867	1,000	1,000	1,000	1,000	967	983	800	783
16	333	933	933	867	1,000	1,000	1,000	1,000	967	250	800	783
17	933	933	667	83	1,000	1,000	250	1,000	967	983	800	783
18	933	933	667	1,000	1,000	1,000	1,000	1,000	250	983	800	300
19	933	933	667	1,000	1,000	500	1,000	1,000	967	983	800	783
20	933	667	167	1,000	1,000	1,000	1,000	1,000	967	983	300	783
21	933	933	667	1,000	1,000	1,000	1,000	250	967	983	700	783
22	933	933	667	1,000	333	1,000	1,000	1,000	967	983	700	783
23	333	933	667	1,000	1,000	1,000	1,000	1,000	967	250	800	783
24	933	933	667	1,000	1,000	1,000	250	1,000	967	800	800	783
25	933	933	667	2,000	1,000	1,000	983	1,000	233	800	800	300
26	933	933	667	2,000	1,000	500	983	1,000	967	800	800	783
27	933	667	167	2,000	1,000	993	983	1,000	967	800	300	783
28	933	933	800	2,000	1,000	993	983	250	967	800	600	783
29	933	.....	800	2,000	417	993	983	1,000	967	800	600	783
30	333	.....	800	2,000	1,000	993	983	1,000	967	200	600	783
31	933	.....	800	.....	1,000	.....	250	1,000	.....	800	.....	783
Mean	836	895	772	1,079	1,185	924	886	903	852	824	700	706

1899.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	300	767	767	683	667	667	750	667	700	233	667	643
2	783	767	767	250	667	667	233	667	700	667	667	643
3	783	767	767	500	667	667	750	667	233	667	667	233
4	783	767	767	500	667	233	750	667	683	667	667	661
5	783	250	250	500	667	667	750	667	683	667	233	661
6	783	750	667	500	667	667	750	233	683	667	663	661
7	783	750	667	500	233	667	750	667	683	667	663	661
8	250	750	667	500	667	667	750	667	683	233	663	661
9	767	750	667	267	667	667	233	667	683	633	263	661
10	767	750	667	500	667	667	667	967	233	633	663	233
11	767	750	667	533	667	233	667	667	683	633	663	637
12	767	250	250	533	667	667	667	667	683	633	233	637
13	767	750	667	533	667	667	667	233	683	633	660	637
14	767	750	667	533	233	667	667	667	683	633	660	637
15	250	750	667	533	667	667	667	667	683	233	660	637
16	767	750	667	267	667	667	233	667	683	633	660	637
17	767	750	667	533	667	667	667	667	233	633	660	283
18	767	750	667	533	667	233	667	667	667	683	660	637
19	767	250	250	533	667	667	667	667	667	683	233	637
20	767	767	683	533	667	667	667	233	667	683	655	637
21	767	767	683	533	233	667	667	700	667	683	655	637
22	250	767	683	533	667	667	667	700	667	233	655	637
23	767	767	683	267	667	667	233	700	667	667	655	637
24	767	767	683	567	667	667	667	700	233	667	655	250
25	767	767	683	567	667	233	667	700	667	667	655	583
26	767	250	250	567	667	750	667	700	667	667	233	583
27	767	767	683	567	667	750	667	233	667	667	643	583
28	767	767	683	567	233	750	667	700	667	667	643	583
29	250	.....	683	567	667	750	667	700	667	233	643	583
30	767	.....	683	233	667	750	233	700	667	667	643	583
31	767	.....	683	.....	667	.....	667	700	.....	667	.....	417
Mean	688	689	632	491	611	623	615	622	618	590	601	574

Daily discharge, in second-feet, of Presumpscot River, etc.—Continued.

1900.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	500	493	500	467	1,833	975	367	770	653	793	647	667
2	500	493	500	750	1,833	975	807	770	330	793	647	365
3	500	493	500	750	1,833	650	807	770	643	793	647	683
4	500	367	417	750	1,833	827	807	770	643	793	370	683
5	500	367	493	750	1,833	827	807	361	643	793	647	683
6	500	367	493	750	1,833	827	807	761	643	793	647	683
7	367	367	493	750	1,833	827	807	761	643	350	647	683
8	483	617	493	383	1,833	827	361	761	643	525	647	683
9	483	617	493	607	1,833	827	793	761	324	525	647	347
10	483	617	493	607	1,833	633	793	761	637	525	647	667
11	483	367	417	607	1,833	833	793	761	637	525	370	667
12	483	600	633	607	1,833	833	793	361	637	525	613	667
13	483	347	633	607	1,833	833	793	655	637	525	613	667
14	367	347	633	607	1,191	833	793	655	637	341	613	667
15	467	347	633	383	1,191	833	361	655	637	603	613	667
16	467	347	633	900	1,191	833	787	655	324	603	613	420
17	467	633	633	900	1,191	561	787	655	620	603	613	653
18	467	400	217	900	1,191	760	787	655	620	603	365	653
19	467	633	808	900	1,191	760	787	330	620	603	665	653
20	467	633	808	900	650	760	787	650	620	603	665	653
21	367	633	808	900	841	760	787	650	620	341	665	653
22	467	633	808	383	841	760	361	650	620	623	665	653
23	467	633	808	1,193	841	760	780	650	330	623	665	420
24	467	633	808	1,193	841	391	780	650	707	623	665	651
25	467	367	247	1,103	841	613	780	650	707	623	365	651
26	467	500	627	1,193	841	613	780	330	707	623	667	651
27	467	500	627	1,193	650	613	780	653	707	623	667	651
28	367	500	627	1,193	975	613	780	653	707	341	667	651
29	493	-------	627	1,833	975	613	361	653	707	647	667	651
30	493	-------	627	1,833	975	613	770	653	330	647	667	283
31	493	-------	627	-------	975	-------	770	653	-------	647	-------	647
Mean	466	495	586	866	1,330	746	721	649	598	599	610	615

1901.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	647	673	667	538	673	728	747	693	300	650	630	267
2	647	673	667	538	673	466	747	693	653	650	630	697
3	647	550	550	538	673	993	747	693	653	650	283	697
4	647	667	693	538	673	993	747	300	653	650	717	697
5	647	667	693	538	333	993	747	693	653	650	717	697
6	367	667	693	538	683	993	747	693	653	283	717	697
7	643	667	693	367	683	993	400	693	653	647	717	697
8	643	667	693	0	683	993	713	693	300	647	717	267
9	643	667	693	0	683	466	713	693	642	647	717	700
10	643	550	567	15	333	795	713	693	642	647	283	700
11	643	660	733	175	333	795	713	300	642	647	667	700
12	643	660	733	175	333	795	713	520	642	647	667	700
13	367	660	467	175	693	795	713	520	642	283	667	700
14	641	660	467	300	693	795	400	520	642	317	667	700
15	641	660	583	633	693	795	707	520	300	317	667	200
16	641	660	667	633	693	450	707	520	667	317	667	583
17	641	517	333	633	693	712	707	520	667	643	233	583
18	641	673	733	633	693	712	707	300	667	643	663	700
19	641	673	733	633	333	712	707	543	667	643	663	700
20	641	673	733	633	708	712	707	543	667	283	663	700
21	637	673	733	300	708	712	400	543	667	687	663	700
22	637	673	500	500	708	712	700	543	300	687	663	200
23	637	673	500	333	708	400	700	543	658	687	663	700
24	637	550	333	333	350	623	700	543	658	687	267	700
25	637	667	683	333	350	623	700	300	658	687	657	700
26	637	667	683	667	333	623	700	662	658	687	657	700
27	367	667	683	667	728	623	700	662	658	283	657	700
28	673	667	683	333	728	623	300	662	658	630	657	700
29	673	-------	683	673	728	623	693	662	300	630	657	200
30	673	-------	683	673	728	400	693	662	650	630	657	700
31	673	-------	367	-------	728	-------	693	662	-------	630	-------	700
Mean	619	649	623	466	605	722	670	575	596	574	618	616

The following tables give the maximum, minimum, and mean monthly discharge of Presumpscot River and the rainfall and run-off of the basin. The mean discharge is computed for the days on which the flow is given, while the run-off is computed for the total number of days in the month. There is only one rainfall station in the basin, viz, at North Bridgton, and that is maintained by a voluntary observer. As the record at that station is short the record of the United States Signal Service at Portland is given instead, as representing approximately the rainfall in the Presumpscot Basin.

Estimated monthly discharge of Presumpscot River at the outlet of Sebago Lake.

[Drainage area, 470 square miles.]

Month.	Discharge in second-feet.			Run-off.		Rainfall, in inches.
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.	
1887.						
January	933	860	902	1.60	1.84	3.89
February	933	933	933	1.70	1.77	5.73
March	1,003	850	920	1.71	1.97	4.15
April	933	933	933	1.72	1.92	4.96
May	1,000	933	979	1.95	2.25	1.93
June	1,000	908	978	2.01	2.24	4.07
July	933	837	901	1.61	1.86	4.70
August	974	837	898	1.66	1.91	6.56
September	933	933	933	1.72	1.92	0.70
October	933	933	933	1.66	1.91	2.47
November	933	933	933	1.72	1.92	4.74
December	964	933	950	1.76	2.03	5.17
The year	1,003	837	933	1.74	23.54	49.07
1888.						
January	974	964	969	1.73	1.99	6.05
February	964	857	861	1.58	1.70	5.40
March	960	866	910	1.69	1.95	3.72
April	933	866	909	1.61	1.80	3.80
May	1,667	933	1,363	2.71	3.13	3.36
June	1,667	933	1,117	2.30	2.56	2.79
July	933	852	884	1.58	1.82	1.90
August	852	825	836	1.55	1.79	4.36
September	933	818	878	1.56	1.74	8.22
October	818	695	741	1.38	1.59	7.47
November	933	695	829	1.53	1.71	7.46
December	1,000	933	948	1.69	1.95	4.71
The year	1,667	695	937	1.74	23.73	59.24
1889.						
January	1,000	933	952	1.83	2.11	3.47
February	1,000	933	985	2.10	2.19	2.74
March	1,414	1,000	1,101	2.34	2.70	2.68
April	1,000	1,000	1,000	2.13	2.38	2.39
May	1,000	933	996	2.12	2.45	2.65
June	933	933	933	1.92	2.14	3.26
July	933	933	933	1.73	1.99	3.10
August	933	866	919	1.71	1.97	2.76
September	866	850	853	1.51	1.68	2.49
October	894	830	847	1.57	1.81	3.47
November	894	858	883	1.63	1.82	7.95
December	967	749	872	1.56	1.80	4.96
The year	1,414	749	940	1.85	25.04	41.92
1890.						
January	982	881	930	1.73	1.99	2.89
February	982	973	979	1.78	1.85	4.04
March	991	889	931	1.66	1.91	6.24
April	1,336	904	1,123	2.23	2.49	2.51
May	1,336	1,262	1,326	2.82	3.26	6.10
June	1,262	884	981	1.74	1.94	4.53
July	957	425	802	1.49	1.72	3.58

Estimated monthly discharge of Presumpscot River, etc.—Continued.

Month.	Discharge in second-feet.			Run-off.		Rainfall, in inches.
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.	
1890.						
August	904	733	857	1.58	1.82	2.99
September	881	858	869	1.60	1.79	4.88
October	1,063	881	957	1.78	2.05	6.82
November	973	898	958	1.70	1.90	2.31
December	1,046	956	994	1.84	2.12	5.08
The year	1,336	425	976	1.83	24.84	51.97
1891.						
January	1,034	929	981	1.82	2.10	7.71
February	965	956	961	1.75	1.82	4.31
March	1,670	514	958	1.71	1.97	5.48
April	1,670	1,670	1,670	3.08	3.44	1.89
May	1,670	1,008	1,155	2.14	2.47	3.47
June	1,008	800	975	1.79	2.00	2.77
July	973	717	835	1.55	1.79	4.78
August	966	690	881	1.57	1.81	1.15
September	916	877	902	1.66	1.85	1.94
October	966	852	912	1.69	1.95	3.22
November	922	793	866	1.53	1.71	2.38
December	793	741	758	1.40	1.61	4.17
The year	1,670	514	988	1.81	24.52	43.27
1892.						
January	867	638	792	1.42	1.64	4.22
February	855	780	811	1.49	1.61	2.18
March	793	741	768	1.42	1.64	2.27
April	806	617	723	1.33	1.48	1.04
May	754	709	727	1.30	1.50	4.41
June	793	595	726	1.33	1.48	4.60
July	896	595	796	1.42	1.64	2.68
August	875	806	833	1.54	1.78	8.14
September	833	667	744	1.37	1.53	2.89
October	667	582	605	1.08	1.25	1.64
November	601	521	572	1.06	1.18	3.76
December	583	567	577	1.07	1.23	1.82
The year	896	521	723	1.32	17.96	39.15
1893.						
January	600	167	514	1.09	1.26	2.19
February	601	167	530	1.13	1.18	4.51
March	612	167	510	1.09	1.26	3.58
April	708	167	521	1.11	1.24	3.71
May	900	167	628	1.25	1.44	7.59
June	900	167	797	1.53	1.71	3.62
July	833	167	679	1.44	1.66	0.96
August	775	167	640	1.36	1.57	2.74
September	783	167	729	1.55	1.73	2.33
October	800	167	687	1.41	1.63	5.13
November	833	167	650	1.38	1.54	1.83
December	867	200	717	1.53	1.76	5.42
The year	900	167	634	1.32	17.98	43.61
1894.						
January	833	208	749	1.59	1.83	3.13
February	800	167	628	1.34	1.39	2.70
March	682	525	583	1.08	1.25	1.97
April	675	133	461	0.98	1.09	2.55
May	800	133	622	1.32	1.52	7.33
June	800	167	649	1.38	1.54	2.01
July	817	133	608	1.29	1.49	2.96
August	717	100	613	1.30	1.50	3.27
September	567	133	491	1.04	1.16	2.76
October	550	133	492	1.05	1.21	4.65
November	542	133	484	1.03	1.15	2.05
December	767	133	610	1.30	1.50	1.75
The year	833	100	583	1.23	16.63	37.13
1895.						
January	758	133	665	1.41	1.63	2.47
February	750	133	625	1.33	1.38	0.94
March	667	133	596	1.19	1.37	3.57

Estimated monthly discharge of Presumpscot River, etc.—Continued.

Month.	Discharge in second-feet.			Run-off.		
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.	Rainfall, in inches.
1895.						
April	783	133	512	1.09	1.22	5.95
May	783	167	634	1.35	1.56	1.59
June	700	167	601	1.28	1.43	1.97
July	675	133	519	1.10	1.27	3.59
August	600	133	511	1.09	1.26	4.72
September	583	133	505	1.07	1.19	1.79
October	617	133	475	1.01	1.16	1.91
November	617	104	464	0.99	1.10	7.18
December	533	125	432	0.92	1.06	3.30
The year	783	104	545	1.15	15.63	38.78
1896.						
January	533	250	472	1.00	1.15	2.00
February	547	133	484	1.03	1.11	5.27
March	633	133	515	0.85	0.98	8.02
April	1,167	118	670	1.38	1.54	1.65
May	1,167	117	795	1.69	1.95	3.21
June	950	100	815	1.73	1.93	2.23
July	950	117	771	1.64	1.89	3.10
August	833	100	696	1.48	1.71	2.57
September	833	100	657	1.35	1.51	9.57
October	800	100	638	1.36	1.57	3.19
November	800	100	667	1.42	1.58	2.45
December	833	100	721	1.53	1.76	2.18
The year	1,167	100	658	1.37	18.68	45.44
1897.						
January	817	700	790	1.41	1.63	4.09
February	833	758	806	1.47	1.53	2.60
March	833	542	756	1.40	1.61	4.55
April	667	367	495	0.91	1.02	2.60
May	817	600	659	1.17	1.35	5.87
June	833	617	772	1.42	1.58	4.97
July	1,200	250	844	1.57	1.81	2.62
August	1,433	883	1,050	1.87	2.16	1.41
September	950	775	908	1.67	1.86	2.34
October	1,000	775	944	1.69	1.95	0.46
November	917	700	817	1.51	1.68	6.69
December	933	867	912	1.69	1.95	4.22
The year	1,433	250	813	1.48	20.13	42.42
1898.						
January	933	333	836	1.78	2.05	6.61
February	933	667	895	1.90	1.98	7.61
March	933	167	772	1.64	1.89	1.21
April	2,000	83	1,079	2.30	2.56	4.33
May	2,000	333	1,185	2.52	2.91	2.62
June	1,000	333	924	1.97	2.20	3.98
July	1,053	250	886	1.88	2.17	1.78
August	1,000	250	903	1.92	2.21	3.88
September	1,000	233	852	1.81	2.02	3.48
October	1,000	200	824	1.75	2.02	5.90
November	800	200	700	1.49	1.66	5.51
December	800	300	706	1.50	1.73	2.85
The year	2,000	83	880	1.87	25.40	49.76
1899.						
January	783	250	688	1.46	1.68	3.39
February	767	250	689	1.47	1.53	3.41
March	767	250	632	1.34	1.54	6.49
April	683	233	491	1.04	1.16	1.55
May	667	233	611	1.30	1.50	0.73
June	750	233	623	1.33	1.48	1.04
July	750	233	615	1.31	1.51	3.92
August	700	233	622	1.32	1.52	1.66
September	700	233	618	1.31	1.46	4.47
October	683	233	590	1.26	1.45	1.46
November	667	233	601	1.28	1.43	3.11
December	643	233	574	1.22	1.41	2.84
The year	783	233	613	1.30	17.67	34.07

Estimated monthly discharge of Presumpscot River, etc.—Continued.

Month.	Discharge in second-feet.			Run-off.		Rainfall, in inches.
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.	
1900.						
January	500	367	466	0.99	1.14	6.28
February	633	347	495	1.05	1.09	9.25
March	808	217	586	1.25	1.44	6.00
April	1,833	383	866	1.84	2.05	2.25
May	1,833	650	1,330	2.83	3.27	4.09
June	975	391	746	1.59	1.77	1.25
July	807	361	721	1.53	1.76	1.70
August	770	330	649	1.38	1.59	3.72
September	707	324	598	1.27	1.42	2.56
October	793	341	599	1.27	1.46	5.81
November	667	365	610	1.30	1.45	5.50
December	683	283	615	1.31	1.51	2.38
The year	1,833	217	690	1.47	19.95	50.79
1901.						
January	673	367	619	1.32	1.52	3.34
February	673	333	649	1.38	1.44	1.65
March	733	333	623	1.33	1.53	4.88
April	673	15	466	0.92	1.03	5.58
May	728	333	605	1.29	1.49	3.29
June	993	400	722	1.54	1.72	5.45
July	747	300	670	1.43	1.60	0.91
August	693	300	575	1.22	1.36	2.48
September	667	300	596	1.27	1.46	2.92
October	687	283	574	1.22	1.41	1.72
November	717	233	618	1.31	1.46	1.91
December	700	200	616	1.31	1.51	6.02
The year	993	15	611	1.28	17.53	40.15

The following table gives the run-off in the Presumpscot Basin for the years 1887 to 1901, inclusive:

Run-off, in second-feet, per square mile, in basin of Presumpscot River.

[Drainage area, 470 square miles.]

Month.	1887.	1888.	1889.	1890.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.	1901.	Average.
January	1.60	1.73	1.83	1.73	1.82	1.42	1.09	1.59	1.41	1.00	1.41	1.78	1.46	0.99	1.32	1.48
February	1.70	1.58	2.10	1.78	1.75	1.49	1.13	1.34	1.33	1.03	1.47	1.90	1.47	1.05	1.38	1.50
March	1.71	1.69	2.34	1.66	1.71	1.42	1.09	1.08	1.19	0.85	1.40	1.64	1.34	1.25	1.33	1.45
April	1.72	1.61	2.13	2.23	3.08	1.33	1.11	0.98	1.09	1.38	0.91	2.30	1.04	1.84	0.92	1.58
May	1.95	2.71	2.12	2.82	2.14	1.30	1.25	1.32	1.35	1.69	1.17	2.52	1.30	2.83	1.29	1.85
June	2.01	2.30	1.92	1.74	1.79	1.33	1.53	1.38	1.28	1.73	1.42	1.97	1.33	1.59	1.54	1.66
July	1.61	1.58	1.73	1.49	1.55	1.42	1.44	1.29	1.10	1.64	1.57	1.88	1.31	1.53	1.43	1.50
August	1.66	1.55	1.71	1.58	1.57	1.54	1.36	1.30	1.09	1.48	1.87	1.92	1.32	1.38	1.22	1.50
September	1.72	1.56	1.51	1.60	1.66	1.37	1.55	1.04	1.07	1.35	1.67	1.81	1.31	1.27	1.27	1.45
October	1.66	1.38	1.57	1.78	1.69	1.08	1.41	1.05	1.01	1.36	1.69	1.75	1.26	1.27	1.22	1.41
November	1.72	1.53	1.63	1.70	1.53	1.06	1.38	1.03	0.99	1.42	1.51	1.49	1.28	1.30	1.31	1.39
December	1.76	1.69	1.56	1.84	1.40	1.07	1.53	1.30	0.92	1.53	1.69	1.50	1.22	1.31	1.31	1.44
The year	1.74	1.74	1.85	1.83	1.81	1.32	1.32	1.23	1.15	1.37	1.48	1.87	1.30	1.47	1.28	1.52

Ratio of run-off to rainfall in basin of Presumpscot River and Sebago Lake.

	1887.	1888.	1889.	1890.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.	1901.	Average.
Precipitation, inches	49.07	59.24	41.92	51.97	43.27	39.15	43.61	37.14	38.78	45.44	42.42	49.76	34.07	50.70	40.15	44.45
Run-off, inches	23.54	23.73	25.04	24.84	24.52	17.96	17.98	16.63	15.63	18.68	20.13	25.40	17.67	19.95	17.53	20.62
Ratio	0.48	0.40	0.60	0.48	0.57	0.46	0.41	0.45	0.40	0.41	0.47	0.51	0.52	0.39	0.44	0.46

SACO RIVER.

DRAINAGE BASIN.

Saco River rises in the White Mountain region of New Hampshire at an elevation of about 1,900 feet above the sea, and has a general southeasterly course to the Atlantic Ocean. (See Pl. X, p. 70.) The greatest length of the basin from Mount Washington to the sea is about 75 miles, the greatest width about 30 miles. The total drainage area is 1,750 square miles, about equally divided between Maine and New Hampshire. The general elevation of the basin is greater than that of any of the larger streams of Maine except the Androscoggin. The headwaters are in one of the highest and roughest mountain regions in the eastern portion of the United States, with steep, wooded slopes and narrow river valleys and with heavy falls to the mountain streams. The mountains grow gradually lower, however, as the ocean is approached, becoming undulating hills in the central portion of the basin and comparatively flat land near the sea. The northern part of the basin is still largely wooded, while in the southern part practically all of the forests have been cut, so that more than half of the entire basin has been cleared. The country rock is granite, which abounds throughout the area, making excellent building material for dams and foundations. Gneisses and schists occur in places. The surface covering over the larger part of the region is sand and gravel.

The drainage area of the river at various points is given in the following table:

Drainage areas of Saco River.

	Sq. miles.
Fryeburg	439
Great Falls, at Hiram	856
Highland Rips	1,366
Bonny Eagle Falls	1,578
Salmon Falls	1,628
Union Falls	1,677
Saco and Biddeford	1,734
Mouth	1,753

The river is navigable as far as Biddeford and Saco, and has good transportation facilities nearly its entire length, being closely followed by the Maine Central Railroad.

LAKE STORAGE.

Although Saco River has no tributary lakes as large as Moosehead or the Schoodics, it contains about 84 square miles of lake surface, 55 square miles in Maine and 29 square miles in New Hampshire. No records of actual measurements of flow of the river are available. Wells states that during summer droughts the discharge at Saco is 300 cubic

feet per second average for the twenty-four hours, and Prof. George F. Swain estimated the minimum flow there at not far from 250 cubic feet per second. Near the headwaters, as has been stated, the river fluctuates rapidly, due to the mountainous character of the basin. Owing, however, to the marshes and lowlands, which are overflowed at the time of high water, to the narrowness of the "gates" (the passage at Hiram Falls which holds back the mountain water), to the comparative levelness of the lower part of the basin, and more particularly to the storage in lakes and ponds, the flow in the lower part of the stream is more constant. The flow could be regulated to a far greater extent, however, by the construction of small dams at the outlets of the lakes. The Saco Water Power Company controls Great Ossipee Lake, covering 3,809 acres, with 5 feet of storage; Moose Lake, covering 1,648 acres, with 9⅔ feet of storage; and four other ponds ranging in size from 150 to 525 acres and in depth of storage from 4 to 9 feet. The extreme range between high and low water at the Great Falls is 12 feet, at the Bonny Eagle Falls 6 feet, and at Saco from 8 to 10 feet.

Ossipee River is the largest tributary of the Saco, entering the main stream near Great Falls. It drains Ossipee Lake, in New Hampshire; has a length of about 20 miles, and a drainage basin of 470 square miles. The storage in Ossipee and other lakes serves to render the flow rather uniform, and this fact, combined with the considerable fall (amounting to 142 feet below the source), gives the stream value for power.

WATER POWERS.

For the first few miles from its source Saco River is a mountainous stream, with fluctuating flow, becoming a rivulet in summer and a mountain torrent in the spring. It falls more than 1,100 feet in the first 12 miles, or about 90 feet per mile. In the next 18½ miles the average slope in successive intervals steadily diminishes from 28½ feet per mile to 6.8 feet per mile, the fall in the entire distance, from the western boundary of the town of Bartlett to the railroad crossing at Conway Center, amounting to 333 feet. Next follows a long stretch of dead water, with a fall of only 69 feet in 28 miles, or 2½ feet per mile. Then are encountered the Great Falls at the town of Hiram, where the river descends 72 feet in a distance of about 900 feet (see Pl. XIV), and finally, in the 40 miles to tide water at Biddeford and Saco, the fall amounts in the aggregate to 271 feet, or an average of 6.6 feet per mile. The following table gives the fall in the river from its source to the sea:

GREAT FALLS ON SACO RIVER AT HIRAM.

Fall in Saco River.

Locality.	Distance from mouth of river.	Height above tide.	Fall between points.	Distance between points.	Average fall per mile between points.
	Miles.	*Feet.*	*Feet.*	*Miles.*	*Feet.*
Source of river	104	1,880			
			1,135	12.5	90.8
Western boundary of Bartlett	91½	745			
			185	6.5	28.5
Mouth of Rocky Branch	85	560			
			49	2.0	24.5
Mouth of Ellis River	83	511			
			65	5.0	13.0
Boston and Maine Railroad crossing	78	446			
			34	5.0	6.8
Conway Center railroad crossing	73	412			
			69	28.0	2.5
Head of Great Falls	45	343			
			72	(a)	
Foot of Great Falls	44½	271			
Mouth of Ossipee River	40	266			
			271	40.8	6.6
Tide water at Biddeford and Saco	4	0			

a 900 feet.

The important portion of the river is that extending from Great Falls to tide water, covering, as has been stated, a fall of 271 feet in about 40 miles, the drainage area increasing from 856 to 1,734 square miles. The principal owner of power is the Saco Water Power Company, which controls the privileges at Biddeford and Saco, Union Falls, Salmon Falls, and Hiram.

At Biddeford and Saco the river falls over trap ledges, giving a total descent from above the upper dam to tide water of about 40 feet, fluctuating somewhat with the tide. At the upper dam, where the fall is 6½ feet, the power is used only by a sawmill. The remaining fall of 33 or 34 feet, constituting the principal power, is utilized by three cotton manufacturing companies. The York Manufacturing Company, whose mill is on an island in the river, owns 11 mill powers, utilizing 30 feet of fall and 275 cubic feet per second of water, or 937 gross horsepower. Of the remaining power the Pepperell Manufacturing Company owns four-sevenths and the Laconia Manufacturing Company three-sevenths, and these two companies control the Saco Water Power Company, the nominal owner of the power. Their mills are on the south bank of the river, where by a dam across the southern arm of the stream the total fall of 33 or 34 feet is divided into two falls of about equal amount, the Pepperell Company using the upper fall and the Laconia Company the lower fall. The two companies have a total of about 4,500 horsepower of turbines, but can obtain the full capacity of these probably not more than two-thirds of the year. During the rest of the time they rely largely upon steam power, of which they have 3,700 horsepower. The pondage here is small, but is sufficient at points upstream to store all the night flow at low stages.

At Union Falls, about 8 miles above Saco, a fall of 15 feet is caused by a dam maintained for the purpose of holding storage above. This dam is owned by the Saco Water Power Company, as is also the succeeding dam, 20 feet high, at Salmon Falls; but the power at both of these dams, as well as that represented in considerable rapids below the dams, is unutilized. At Salmon Falls the total descent is said to be 62 feet in 3,500 feet, the river running through a narrow, rocky channel with almost vertical banks. A view of the river below these falls is shown in Pl. XIII, *B*.

The next privilege is at Bar Mills, where the Boston and Maine Railroad crosses the river. Here a fall of 18 feet is available, and the power is partly utilized by a furniture factory, a gristmill, and two sawmills. Four or 5 miles above are the Moderation Falls, at which a head of 16 feet is obtained, the power being used for small woolen mills and sawmills. A mile or two farther upstream, and somewhat less than 20 miles due west of the city of Portland, are the Bonny Eagle Falls. The power here is not now utilized. Formerly there was a small sawmill on an island at the head of the falls. Below this mill site heavy rapids extend for perhaps a half mile downstream, giving a total fall on the privilege of 48 feet. The power is an important one, and the site presents favorable features with respect to pondage and facilities for improvement.

Five or 6 miles above Bonny Eagle are heavy rapids extending a third of a mile along the stream, constituting what are known as the Limington Falls, and about a mile farther up are other rapids a quarter of a mile in length. The fall at these two localities is given by Wells as 65 feet and 26 feet, respectively, but the figures seem much too high. At the head of the lower or principal falls the banks are rather low on each side, but a short distance downstream there is a rocky island, and the river banks and bed are also of rock, offering a favorable location for a dam. The river is probably from 250 to 350 feet wide in this portion of its course.

The next water power is at Steep Falls, about 2 miles up the river from the upper rapids just mentioned, and about 25 miles above the power at Saco and Biddeford. Here a dam gives a maximum fall of about 12 feet, the power being used by a pulp mill.

Above Steep Falls there are said to be occasional rapids along the river, probably the most prominent being the Highland Rips, before reaching the Great Falls, in Hiram, about 45 miles above the mouth of the river. Here the stream descends, in successive pitches, a total of 72 feet in 900 feet. An island divides the river at the head of the falls, the banks are of rock, and the topography appears favorable for the development and utilization of the power. The Maine Central Railroad, from Portland to Conway, skirts the east bank of the river at the foot of the falls. This privilege, which is one of exceptional importance, is owned by the Saco Water Power Company, and is

practically unimproved. A high dam can be built here, however, without excessive damage for flowage.

Above Great Falls there is quiet water for about 30 miles, and beyond that the river has too small a drainage area and too variable a flow to be worth consideration.

ST. JOHN RIVER.

DRAINAGE BASIN.

St. John River drains the whole northern portion of Maine as well as large areas in Canada. The topographic character of its basin is widely different from that of any of the streams on the southern slope of Maine. The total drainage area in Maine and Canada is given by Wells as 26,000 square miles, while that in Maine is stated to be 7,400 square miles. Swain gives the area drained by the river and its tributaries in Maine as 8,000 square miles. The greatest length of the basin in the State is about 117 miles and the greatest width from north to south about 90 miles. Next to the Androscoggin this is the most elevated drainage area in Maine, the whole basin being at a considerable altitude and not portions of it at an extreme elevation. For this reason the fall of the stream and the possibilities of the development of water power are far less than upon any of the other large rivers of the State.

The surface topography is of remarkable uniformity. In the eastern, or lower, portion the surface of the country is almost level near the river, and at a distance from the stream it becomes undulating and moderately hilly until it subsides and is merged into the flat country bordering Aroostook River. Highlands or elevations diversify its aspect in the district about the mouths of the St. Francis and the Alleguash. Below those streams the valley of the Upper St. John is quite level to near the boundary highlands on the west and southwest. Large portions of this area are swampy, and the watershed is too flat to throw off the surplus water into the drainage channels.

By far the greater portion of the basin is forested and is comparatively unknown. The rocks prevailing in the eastern part are limestone and slate, with patches of sandstone, quartz rock, and granite, while about three-fourths of the total area is clay slate. On the west, bordering the river on both sides through the upper two-thirds of its length, is a tract of mica-schists. The rock is less exposed than upon the southern slope, and building stone is less readily procurable.

The total length of the river in Maine is estimated to be not far from 211 miles, including the more important meanderings. Its total length from its remotest sources to the sea is about 450 miles. The river receives a large number of tributaries throughout its course, several of which drain lakes and ponds of considerable size.

The greater part of the basin is inaccessible, with few railroads or

highways. The main river is followed closely by the railroad from Frederickton, New Brunswick, up to Edmundston, New Brunswick, on the northern boundary of Maine. The Bangor and Aroostook Railroad crosses the eastern part of the portion of the basin in Maine, but throughout the whole of the upper basin there is neither railroad nor highway.

LAKE STORAGE.

The surface area of lakes in the St. John system is 350 square miles. About 36 square miles of lake surface naturally belonging to it have, by artificial means, been made tributary to the Penobscot. It is probable that a large number of small lakes and ponds in the wilderness districts of the basin are not represented upon the maps, and that if these were included the total lake surface would be somewhat increased. The basin has, however, become more thoroughly channeled with water courses than the southern slope of the State, and many ancient lakes have been obliterated. There is little doubt that the valley of the Walloostook (Upper St. John) was once a long and narrow lake, also the valley of the St. John above the Great Falls for a long distance. The maps of Maine show more than 1,500 tributaries to the river.

No measurements of the discharge of the river have been made, and but little information is obtainable in regard to its variations in flow. The general uniformity of the tributary area, however, favors only moderate rises in the stream, while on the other hand a moderate slope of the river tends to large accumulations of water, the surplus not being passed off rapidly. The characteristics of the basin indicate that the low-water flow of the river and its many tributaries is large. The levelness of the drainage surfaces, the density of the forests, and the low annual temperature must go far toward retaining the precipitation to eke out the low-water flow.

WATER POWERS.

The elevation of the St. John at the State boundary is 419 feet above tide, and at the mouth of the St. Francis 606 feet. The distance between these two points being 70 miles, the mean slope is about 2.6 feet per mile. At the source of the main stream, which is formed by the junction of three tributaries, the elevation is about 750 feet. The distance from the source to the State boundary is 158 miles, showing the mean slope in that distance to be 1.8 feet per mile. It has been stated that the river is navigable throughout a large part of its course.

Comparatively little is known of the water powers of this region, and it is likely that they will remain undeveloped until proper transportation facilities are obtained. Owing to their inaccessibility, their small fall, and the comparative scarcity of building stone, the powers

on the river are not of as great interest as those of the streams on the southern slope of Maine, yet, in future years, many of them will surely be developed, and, on account of the numerous tributary lakes, they will be reliable throughout the year. It is likely that lumbering, and, possibly, pulp and paper manufacturing, will be the leading manufacturing industries.

TRIBUTARIES OF ST. JOHN RIVER.

The St. John has a number of tributaries which have many of the same characteristics as the main stream—i. e., large tributary lake areas, forested basins, little exposed rock, and comparatively deep and fertile soils, but with falls which, though not great, considerably exceed those of the main stream.

MEDUXNIKEAG AND PRESQUE ISLE RIVERS.

Meduxnikeag River drains about 427 square miles in Maine, and affords a number of powers improved to only a small extent. The Presque Isle drains 209 square miles, and also affords some water-power sites, which are partially improved.

AROOSTOOK RIVER.

Aroostook River is the largest tributary of the St. John. It rises in the highlands in the north-central part of Maine, at an elevation of about 1,050 feet, and unites with the St. John near the eastern State line, where it has an elevation of 345 feet. Its total length being 117 miles, makes the average fall 6 feet per mile. The total area of its drainage basin in Maine is about 2,500 square miles, and the many lakes at its headwaters and on its tributaries cause the flow to be comparatively uniform throughout the year. At a number of points along the Aroostook and its tributaries rapids occur which might be utilized for power purposes. In a few isolated cases developments have been made in a small way.

FISH RIVER.

Fish River, the next tributary of the St. John, has perhaps more decided falls than any of the other tributaries. At Wallagrass Plantation there are two falls, one of 20 feet and the other at the outlet of Eagle Lake, a short distance above, where a dam could be built, raising the lake surface. Near the mouth of Fish River there is a fall of 18 feet which could be utilized. Like the other streams of this basin, Fish River, owing to its extensive lakes, has a comparatively constant flow.

ALLEGUASH RIVER.

Alleguash River is the second largest tributary of the St. John in Maine, and drains about 1,650 square miles. Chamberlain Lake furnishes the headwaters of this stream, which, with the smaller lakes in

its basin, gives to the river a comparatively constant flow throughout the year. The river falls 380 feet in the first 60 miles of its course from Chamberlain Lake, giving an average fall of a little more than 3 feet per mile. There are a number of rapids and small falls along the stream, particularly near the headwaters, but these have not been improved, and owing to their inaccessibility they will not be improved for years to come.

ST. FRANCIS RIVER.

St. Francis River, rising in lakes on the Canada border, forms the northern boundary line of Maine for about 40 miles, and has considerable undeveloped power, particularly at its mouth, where there is a single drop of nearly 30 feet.

UPPER ST. JOHN RIVER.

The Upper St. John is known as Walloostook River. It has a number of rapids and small falls, none of which have been utilized.

COASTAL STREAMS.

The streams described on the foregoing pages comprise the chief drainage basins of Maine and embrace the total area of the State, except tracts along the coast which are drained by smaller streams flowing directly into the ocean. Between the St. Croix and the Penobscot are Dennys, East Machias, West Machias, Narraguagus, Union, and other rivers, and between the Penobscot and the Kennebec are the St. George, the Pemaquan, and others, while at the southwestern extremity are the Mousam and the Piscataqua, the latter forming a part of the western boundary of the State. These streams are all comparatively small, but their importance is greater than their size would indicate, from the fact that they are in a more thickly populated part of the State and are nearer the coast, where transportation facilities are much better than in the interior, and that they have considerable fall and regular flow, due to the lakes and ponds tributary to them.

NARRAGUAGUS RIVER.

The basin of Narraguagus River lies to the west of West Machias River and borders the Atlantic Ocean. Closely associated with the Narraguagus are the Pleasant, the Tunk, the Chandlers, and other smaller streams near the coast, all of which have several sites where the fall is considerable, but the flow small. The combined basin comprises about 550 square miles, divided as follows: Narraguagus, 215 square miles; Pleasant, 110; Tunk, about 60; and Chandlers, about 50. Granite prevails along the coast and throughout the western portion of the district, with mica-schists in the valley of Pleasant River. The surface is level to undulating, with occasional low mountains. A large part of the region is still covered with forests.

Tributary to these rivers are 29 ponds having a combined surface of 21 square miles, making the flow rather constant, though none of the powers are large enough to be of great importance. At the head of tide water on Narraguagus River are the Cherryfield Falls, where six privileges exist, the total fall being 52 feet, affording an excellent power, with a reservoir above sufficient to permit the concentration of the flow into working hours. At the Great Falls, at Deblois, there is a second fall of about 50 feet in a half mile, and the power is said to be a fine one.

EAST MACHIAS AND WEST MACHIAS RIVERS.

The basin of these rivers lies just west of Dennys River and borders the coast, the streams entering Machias Bay. The combined basin has an area of 800 square miles, of which the West Machias drains about 458 square miles and the East Machias about 345 square miles. It is considerably broken with hills and low mountains, the highest part of the district being in the northwest, where the mean height for a considerable extent is about 400 feet. Near the coast the prevailing rock is a quartzite, while farther inland granite abounds, and near the headwaters mica-schists prevail.

The West Machias has considerable fall, its average slope being about 5.8 feet per mile. Owing to the extent of the lake surfaces in the basin (70 square miles), the flow of both streams is rather constant, though the East Machias has the advantage in this particular. The lakes being located largely at the remotest sources of the streams, they exert their equalizing effect throughout their length, and if improved as reservoirs would largely increase their manufacturing capacity. Many of the lakes are dammed and the water is used only for log-driving purposes. The lakes at the source of the West Machias have only short tributaries, and therefore fill slowly and can not be relied upon for especially large amounts of reserve water. The lakes being at the headwaters, are not as valuable for power as if located near the falls, but they assist materially in equalizing the flow throughout the course of the stream.

On the West Machias are a number of water-power sites. At the head of tide and of navigation, 6 miles from the mouth of the stream and 3 miles above where it joins the East Machias, there is a fall of 33 feet to high tide, partially utilized. At the Middle Falls, in Whitney, there is a fall of 10 feet, and at the Great Falls, 5 miles above, in Centerville, a fall of 10 feet, with excellent facilities for improvement. In Northfield there is a fall of 28 feet, at the Holmes Falls, and there are a number of smaller powers above.

On the East Machias the lakes are not all near the headwaters of the stream, but are more equally distributed over the basin, thus rendering the flow of the river rather uniform, although the lakes are

used principally for log-driving purposes. The principal power on the stream is at the head of tide, where the fall is 47 feet in 3 miles, and is used in four privileges. Other powers exist above, though they have been little utilized.

DENNYS, PEMAQUAN, AND OTHER RIVERS.

The drainage basin of Dennys, Pemaquan, and associated streams lies to the south and west of the St. Croix, bordering the Atlantic Ocean and Passamaquoddy Bay. This area comprises about 375 square miles, of which Dennys River drains about 150 square miles; Pemaquan, 40 square miles; the remainder being drained by various small streams. The surface is moderately undulating to level, with scattered low hills. Dennys River has a fall of about 250 feet from Meddybemps Lake to the sea, a distance of 25 miles. The flow is comparatively uniform, owing to the influence of the great lake at its head, the total range at Dennysville being 5 feet. There are five water powers.

UNION RIVER.

Union River, comprised almost wholly within Hancock County, drains an area about 20 miles broad, extending about 70 miles inland from the open sea. The total area above Ellsworth Falls is about 500 square miles. Below that place the coast line is much broken by bays and inlets, so that much of the rainfall flows directly into the ocean. The basin is practically surrounded by bald granite mountains, the interior basin being a strongly defined valley with a rolling surface. The scenery in these highland regions, especially near the coast, is varied and grand. The basin in its northern part is at an elevation of from 225 to 250 feet, while the lowest part of the watershed ridge, between Union and Penobscot rivers, is at altitude of 257 feet. About four-fifths of the whole area is underlain by mica-schists, and a large part of it is still covered with forests.

The river is well supplied with natural storage basins, there being in the basin proper 43 lakes, with a total surface area of about 60 square miles. The height of the lake at the headquarters of the river is about 205 feet above sea level, and the mean fall of the stream from this lake to the sea is 4 feet to the mile. The ponds which have been improved for storage are used chiefly for log-driving, and are therefore not of as much value to the water powers as they should be.

The mean annual rainfall in the basin is about 48 inches, distributed as follows: 12 inches in spring, 10 inches in summer, 14 inches in autumn, and 12 inches in winter, a distribution favorable to constant flow. The extreme range of water at Ellsworth is 7 feet.

The Ellsworth Falls are at the head of tide and navigation and are the first water power on the stream. The fall is stated to be 85 feet

in about 2 miles, and 100 feet in $2\frac{1}{4}$ miles. A part of it is utilized by mills of various kinds, but principally by sawmills.

The upper dam on Union River ponds the water 12 or 15 miles, creating a reservoir large enough to permit the concentration of power into working hours. No measurements of the power available are at hand, but according to estimates of Prof. George F. Swain the minimum power is about 12 horsepower per foot fall, continuous, or 24 horsepower during twelve hours, which would probably be practicable. This would amount to 2,400 horsepower gross on the entire fall of 100 feet. The site is accessible by rail, and the facilities for development are said to be good. The power estimated could of course be largely increased, probably more than doubled, were the reservoirs systematically improved. There are no important powers on the river above this point, though rapids occur at intervals.

The river is navigable as far as Ellsworth Falls, though closed four months of the year by ice. Above the falls ice prevails for a somewhat longer period.

ST. GEORGE, SHEEPSCOT, MEDOMAC, AND DAMARISCOTTA RIVERS.

These streams drain an area of about 800 square miles along the coast between the Penobscot and Kennebec basins. The St. George drains about 228 square miles above the lowest falls, the Sheepscot about 248 square miles, and the Medomac about 62 square miles. Damariscotta River, draining about 43 square miles above the lowest falls, is of unusual importance as a manufacturing stream, on account of the size of its natural reservoir, a pond of the same name. Dyers River, another small stream in this basin, drains an area of about 38 square miles.

The total number of lakes in the basin is 72, though they are all small, their combined area being 50 square miles. They are, however, of much value for pondage in the development of water powers.

The first power on Sheepscot River is a tide power at the Sheepscot Falls. Five miles above, at the head of tide, a fall of 10 feet is used. At The Rapids, the head of which is 2 miles farther up, there is a fall of 25 feet in a mile, with steep banks on both sides, and above this there are several small powers. At the outlet of Damariscotta Pond Damariscotta River falls 52 feet in about 400 feet, and the power is excellent, though small, being rendered constant by the storage in the pond. In the town of Bristol Pemaquid River falls 50 feet in the 500 feet from tide, and the power, being fed from ponds above, is constant, though very small. On Medomac River there are in the town of Waldoboro eight powers, with a total fall of about 80 feet, while other falls occur above. On St. George River there is a woolen mill in the village of Warren, and a power site, known as the Knox

Falls, just above. In the town of Union the stream has considerable fall, and several powers which are in use, while in the upper portion the fall is still greater.

MOUSAM AND KENNEBUNK RIVERS.

These rivers flow into the Atlantic near the southwest corner of Maine and have a combined drainage area of about 260 square miles, of which the Mousam drains about 157 square miles and the Kennebunk about 50 square miles. Their basins are of moderate elevation, with level or moderately undulating surfaces. Granite is almost the only rock occurring. It is of fine quality and is extensively quarried. Nearly all of the forests have been cut and the land is extensively cultivated. The rainfall is about 44 inches, 11 inches falling in spring, 11 inches in summer, 12 inches in autumn, and 10 inches in winter. The river is accessible at nearly all parts by railroad.

The fall of the Mousam is large, probably in the neighborhood of 10 feet per mile, and the flow is constant, owing to the tributary lakes. The first power is 2½ miles from the sea, the fall being 40 feet, in three pitches, only a portion of it being utilized. Two miles above are Lord's cotton mills, with 11 feet fall. A mile farther up is a sawmill with 9 feet fall, then the Varneys Falls with 12 feet fall, then the Great Falls with 45 feet fall, making the total fall about 185 feet. Wells mentions 16 powers in the town of Sanford with a total fall of about 200 feet, and in the towns above the slope is even greater. The bed and banks of the river are everywhere favorable for construction, and the facilities for storage are good.

Kennebunk River, which empties into the ocean near the mouth of the Mousam, is a small stream fed by Kennebunk Pond, which covers about 540 acres and is capable of being drawn down 4 feet, and by Swan Pond, which covers about 480 acres. The stream affords a few small powers.

PISCATAQUA RIVER.

This stream, with Salmon Falls River, forms a part of the western boundary of the State of Maine. Its drainage basin has an area of about 550 square miles, 240 of which are in Maine and 310 in New Hampshire. About 230 square miles only are drained into the river from Maine and New Hampshire above the lowest falls on the Salmon Falls branch. The area is undulating to hilly, the prevailing rock granite, with patches of mica-schists and quartz rock. The forests have been largely cut.

The river is formed by three tributaries—Cocheco, Salmon Falls, and Great Works rivers. Cocheco and Salmon Falls rivers are described in the Twenty-second Annual Report of the United States

Geological Survey, Part IV. The fall from Northeast Pond, at the head of Salmon Falls River, which may be considered the Upper Piscataqua, to the sea is 449 feet, giving a mean descent of 16.6 feet to the mile. There are 22 lakes in the basin, of which 9 are in Maine and 13 in New Hampshire, their combined area being about 16 square miles.

TIDAL POWERS.

There are a number of developed tidal water powers on the coast of Maine. This type of water-power development requires a peculiar configuration of the coast, so that a large body of water can be held in a land-locked bay and allowed to flow gradually to the lower level of the ocean at the time of low tide. The rise of the tide at Eastport, Me., is 18.1 feet, becoming gradually less southward along the coast. At Portsmouth, N. H., near the western boundary of Maine, it is 8.6 feet. The average for the Maine coast is 11.6 feet. South of New England, where the coasts are made up of sand bars and marshes, were the rise of the tide very great it could not be utilized, on account of the difficulty of holding the water at the turn of the tide and of finding foundations for mills. The coast of Maine, being largely of rock, gives all that could be desired in this respect.

In this type of power development there is no difficulty from ice, and transportation by sea is always good. Power can be utilized for sixteen hours out of the twenty-four. In industries where a large number of persons are employed the ever-changing hours of daily running is a disadvantage, but with many kinds of manufacturing this is of no importance. In Maine the power thus developed is largely used for sawmills, gristmills, and plaster mills.

SUMMARY.

It has been shown in the foregoing pages that the water powers of Maine are remarkable, as regards both amount and constancy.

In every county of the State water power has been developed to a greater or less extent and for a great variety of purposes. The lumber mills are still the greatest users of water power, while the paper and pulp industry, which has grown remarkably during the last few years, now ranks second. Cotton mills, woolen mills, and flour and grist mills are the other chief users of power. The following table, data for which were furnished by the United States Census Bureau, gives the amount of water power used in the various industries in the State.

Water power, in horsepower, used by the principal manufacturing industries of Maine.

County.	Lumber mills.	Paper and pulp mills.	Cotton mills.	Woolen mills.	Flour and grist mills.	Boot and shoe factories.	Miscellaneous.	Total.
Androscoggin	1,122	3,050	9,625	1,785	825	.....	640	17,047
Aroostook	2,658	.....	.....	60	916	.....	40	3,674
Cumberland	1,939	5,545	3,725	522	387	85	53	12,256
Franklin	2,141	.....	.....	175	325	25	6	2,672
Hancock	2,055	.....	.....	139	105	.....	22	2,321
Kennebec	2,527	7,530	5,608	673	781	135	106	17,360
Knox	750	.....	.....	375	156	.....	285	1,566
Lincoln	1,428	.....	.....	8	80	.....	.....	1,516
Oxford	3,100	.....	.....	210	400	.....	7	3,717
Penobscot	8,578	[a] 875	.....	1,197	750	.....	70	11,470
Piscataquis	1,625	.....	.....	938	195	.....	4	2,762
Sagadahoc	655	6,850	.....	.....	20	.....	.....	7,525
Somerset	5,159	5,425	.....	1,397	653	.....	107	12,741
Waldo	2,093	300	.....	10	329	.....	130	2,862
Washington	6,402	.....	.....	60	295	.....	10	6,767
York	2,205	200	8,300	650	504	345	140	12,344
Total	44,437	29,775	27,258	8,199	6,721	590	1,620	118,600

[a] The power used at Milinoket is not included in these figures.

It is of considerable interest to note the increased development of water power in the State. The following table, compiled from data furnished by the United States Census Bureau, shows the amount of power, both steam and water, used at the times of taking the last four censuses. It will be noted that the development of water power has been marked, the total amount utilized being more than doubled in the last twenty years. It is also of interest to note that the development now going on is principally in the direction of larger wheels and more extensive plants, shown by the general decrease in the number of wheels and the increase in their horsepower.

Power used by manufactories in Maine at various periods.

Year	Number of establishments.		Total horsepower.	Engines.			
				Steam.		Gas or gasoline.	
	Total.	Reporting power.		Number.	Horsepower.	Number.	Horsepower.
1870	5,550	[a]	79,573	[a]	9,465	.....	.....
1880	4,481	1,918	100,476	511	20,759	.....	.....
1890	5,010	2,022	450,508	965	42,796	[b]	10
1900	6,702	2,377	271,547	1,681	90,751	115	2,405

Year.	Water wheels.		Electric motors.		Other powers.	
	Number.	Horsepower.	Number.	Horsepower.	Number.	Horsepower.
1870	[a]	70,108	.....	.....	.....	.....
1880	2,887	79,717	.....	.....	.....	.....
1890	2,396	104,602	[b]	191	[b]	39
1900	2,179	167,264	97	2,087	23	226

[a] Not reported. [b] Not reported separately.

It is of interest in this connection to compare the development of the water powers of Maine with those of the United States. For this purpose the following table, showing the amount of power used in the United States at the times of taking the last four censuses, is inserted:

Power used by manufactories in the United States at various points.

Year.	Number of establishments.		Total horsepower.	Engines.			
				Steam.		Gas or gasoline.	
	Total.	Reporting power.		Number.	Horsepower.	Number.	Horsepower.
1870	252,148	(a)	2,346,142	(a)	1,215,711		
1880	253,852	85,923	3,410,837	56,483	2,185,458		
1890	355,415	100,735	5,954,655	91,410	4,581,595	(b)	8,930
1900	512,721	169,326	11,318,914	157,667	8,756,829	14,890	143,786

Year.	Water wheels.		Electric motors.		Other powers.	
	Number.	Horsepower.	Number.	Horsepower.	Number.	Horsepower.
1870	(a)	1,130,431				
1880	55,404	1,225,379				
1890	39,008	1,255,206	(b)	15,569	(b)	4,784
1900	39,213	1,727,567	17,282	314,979	2,151	54,540

[a] Not reported. [b] Not reported separately.

The following table shows the number of water wheels in use in the United States at the times of taking the last four censuses, the total horsepower developed by them, and the percentage of gain in the respective decades:

Water wheels in use in Maine at various periods.

Year.	Number of water wheels in use.	Horsepower of wheels.	Percentage of total horsepower.	Increase.	
				Per cent.	*Horsepower.*
1870	(a)	1,130,431	48.2		
1880	55,404	1,225,379	35.9		8.4
1890	39,008	1,255,206	21.1	[b] 29.6	2.4
1900	39,213	1,727,567	15.3	.5	37.6

[a] Not reported. [b] Decrease.

INDEX.

Page.

Adams & Co., power used by ... 34
Alleguash Lake, elevation of ... 17
Alleguash River, power sites on ... 111-112
Androscoggin Pulp Company, power used by ... 74
Androscoggin River, basin of, area, topography, etc., of ... 70-71
  fall in ... 73
  falls on, views of ... 72, 74, 76
  flow of ... 76-91
    diagrams showing ... 85, 86, 88, 89, 90
  lakes in basin of, number, area, etc., of ... 17
  map of basin of ... 70
  powers on ... 72-76
  rainfall in basin of, ratio of run-off to ... 78
  storage in basin of ... 71-72
Arches on Penobscot River, view of ... 30
Aroostook River, power sites on ... 111
Attean Pond, elevation of ... 17
Auburn and Lewiston Electric Light Company, power used by ... 91
Augusta, Cobbosseecontee River near, flow of ... 60-70
  cotton mills at, view of ... 44
  power at ... 45
  rainfall and run-off at ... 67-70
Bangor, power at ... 35
Bar Mills, power at ... 108
Baring, dam at ... 26
Barker Woolen Mills, power used by ... 91
Basin Mills, power at ... 34
Baskahegan Lake, elevation of ... 17
Berlin Falls, power at ... 76
Berlin Mills Company, power used by ... 76
Biddeford, power at ... 107
Birch Island Rips, power site at ... 33
Bodwell Water Power Company, power owned by ... 33
Bonny Eagle Falls, power site at ... 108
Boom on Kennebec River, view of ... 44
Bowdoin Paper Manufacturing Company, power used by ... 74
Brunswick, power at ... 73-74
Brunswick Electric Light Company, power used by ... 74
Burgess Sulphite Fiber Company, power of ... 76
Cabot Manufacturing Company, power owned by ... 74
Calais, power at ... 26
Canadian Cotton Mills Company, mill of, view of ... 26
  power owned by ... 26

Page.

Canoose Rips, fall at ... 24
Carrabassett River, falls on, view of ... 58
  lakes in basin of, area of ... 40
  power sites on ... 58
Carritunk Falls, power at ... 44
Cary, A., cited ... 73
Cauquomogomoc Lake, elevation of ... 17
Cauquomogomoc River, drainage area of ... 28
Centerville, power site at ... 113
Chamberlain Lake, elevation of ... 17
Cherryfield Falls, power site at ... 113
Chesuncook Lake, elevation of ... 17
Chiputneticook Lake, elevation of ... 17
  storage in ... 22
Churchill Lake, elevation of ... 17
Climate, discussion of ... 18
Coastal streams, powers on ... 112-117
Cobbosseecontee River, drainage area of ... 40
  flow of ... 60-70
    diagrams showing ... 65, 66
  rainfall in basin of, relation to run-off ... 70
Costigan, Penobscot River near, discharge of ... 37-38
Crooked Rips, dam at ... 75
Cross Lake, elevation of ... 17
Cumberland Mills, power at ... 92
Cushnoc Paper Company, power used by ... 45
Damariscotta River, power on ... 115
Dana Warp Company, power used by ... 92
Dead River, drainage area of ... 40
  lakes in basin of, area of ... 40
  power sites on ... 58
Deblois, power site at ... 113
Deer Rips, power at ... 75
Dennys River, lakes in basin of, number, area, etc., of ... 17
  powers on ... 114
Eagle Lake, elevation of ... 17
East Branch of Penobscot River, drainage area of ... 28
East Machias River, power site on ... 114
Eaton, H. F., & Sons, power owned by ... 26
Edwards Manufacturing Company, mills of, view of ... 44
  power used by ... 45
Elevations of lakes and ponds ... 17
Ellsworth Falls, power site at ... 114-115
Enfield, power near ... 32
Engel, W., & Co., power used by ... 34
Fairfield Junction Mills and Water Power Company, power owned by ... 45
Farm land, area of ... 15
Ferguson, H. S., work of ... 46
Fish River, power sites on ... 111

Page.
Fish River Lake, elevation of 17
Forest City, storage above 22
Forest stream, view of 14
Forests, extent and character of 15-16
Geology, sketch of 12-15
Glen Manufacturing Company, power used by 75
Grand Falls, power site at 25
Grand Lake, storage in 22
Great Falls of Mousam River, power site at 116
Great Falls of Narraguagus River, power site at 113
Great Falls of Presumpscot River, power at 92
Great Falls of Saco River, power at 108
view of 106
Great Falls of West Machias River, power site at 113
Great Northern Paper Company, dam of 30
power used by 44
Great Works, power at 34
Gregory, H. E., and Williams, H. S., cited 13
Hamlin, G. H., reference to 33
work of 36
Hardy, G. F., work of 37
Hiram, falls at, view of 106
Hollingsworth & Whitney Company, power used by 45
Holmes Falls, power site at 113
Howland, power near 32
Indian Pond, power sites near 43
Indian Spring Woolen Company, power used by 44
International Paper Company, power used by 34, 44
Jay, power at 75
Jay Paper Manufacturing Company, power used by 75
Jordan Lumber Company, power used by 33
Kennebec Fiber Company, power used by 59
Kennebec Light and Heat Company, power used by 45
Kennebec Log Driving Company, improvements made by 41
Kennebec River, basin of, area, topography, etc., of 38-40
fall in 42
flow of 45-57
diagrams showing 52, 53, 54, 55, 56
lakes in basin of, number, area, etc., of 17, 40
log boom on, view of 44
map of basin of 28
powers on 42-45
rainfall in basin of, ratio of run-off to 57
storage in basin of 40-42
Kennebec Water Power Company, improvements made by 41
Kennebunk River, power site on 116
Laconia Manufacturing Company, power owned by 107
Lake. See next word of name.
Lake storage in Androscoggin Basin 71-72
in Kennebec Basin 40-42
in Penobscot Basin 29-30
in Saco Basin 105-106

Page.
Lake storage in St. Croix Basin 21-23
in St. John Basin 110
Lake and forest region, view in 14
Lakes, number, area, and elevation of 16-17
Lawrence, Newhall & Page Company, power owned by 45
Lewiston, power at 74-75
Limington Falls, power site at 108
Lisbon Falls, power at 74
Lisbon Falls Paper Manufacturing Company, power used by 74
Little Androscoggin River, powers on 91
Little Androscoggin Water Power Company, power owned by 91
Little Falls, Penobscot River, power at 92
Little Falls, St. Croix River, power site at 24
Livermore Falls, power at 75
Livermore Falls Pulp Company, power used by 75
Lockwood Company, power of, owned by 46
Log boom on Kennebec River, view of 44
Long Lake, elevation of 17
Long Pond, elevation of 17
Lumber industry, extent of 15-16
Machias River, lakes in basin of, number, area, etc., of 17
See also East Machias River; West Machias River.
Madison, power at 44
Madison Falls, log boom near, view of 44
Madison Woolen Company, power used by 44
Magalloway River, drainage area of 71
Mallison Falls, power at 92
Maine, area of 15
map of 12
Manufacturing, power used in 118-119
Mattagamon Lake, elevation of 17
Mattawamkeag River, drainage area of 28
lakes in basin of, area of 29
Mechanic Falls, power at 91
Medomac River, powers on 115
Meduxnikeag River, power sites on 111
Mercer, F., & Sons, power used by 27
Messalonskee River, drainage area of 40
falls on, view of 58
lakes in basin of, area of 40
powers on 59
Middle Falls, West Machias River, power site at 113
Milinoket Lake, elevation of 17
Milinoket mills, power used by 31
Mills, H. F., work of 93
Mixer, C. A., information furnished by 77
Moderation Falls, power at 108
Mohawk Rips, power site at 32
Moose River, basin of, area and character of 40, 57-58
lakes in basin of, area of 40
Moosehead Lake, dams at outlet of 41
drainage area of 40
east outlet of, view of head gates at 40
elevation of 17
outlets of, views of 40
west outlet of, view of 40
Mooselookmeguntic Lake, elevation of 17

Page.
Mousam River, lakes in basin of, number, area, etc., of ... 17
power on ... 116
Mullen & Engel, power used by ... 34
Murchie, J., & Sons, power used by ... 26
Narraguagus River, lake in basin of, number, area, etc., of ... 17
power sites on ... 112-113
Nekonegan Paper Company, power used by ... 34
Newell, F. H., letter of transmittal by ... 9
North Anson, falls at, view of ... 58
North Lake, storage in ... 25
Northfield, power site at ... 113
Oakland, falls at, view of ... 58
power sites at ... 59
Old Point, power site at ... 44
Oldtown, power at ... 33-34
Oldtown Electric Light Company, power used by ... 33
Oldtown Woolen Company, power used by ... 34
Orono, power at ... 34
rainfall at ... 38
Orono Pulp and Paper Company, power owned by ... 34
Otis Falls, power at ... 75
Otis Falls Pulp Company, power used by ... 75
Pamaluncook Lake, elevation of ... 17
Paper and pulp industry, extent of ... 15-16
Passadumkeag River, drainage area of ... 28
lakes in basin of, area of ... 29
Passadumkeag Rips, power site at ... 33
Pejebscot Mills, power used by ... 74
Pemaquid River, power on ... 115
Penobscot River, arches on, view of ... 30
artificial connection between St. John River and ... 36
basin of, area, topography, etc., of ... 27-29
fall in ... 31
flow of ... 36-38
lake storage in basin of ... 29-30
lakes in basin of, number, area, etc., of ... 17
map of basin of ... 28
powers on ... 30-35
Penobscot Chemical Fiber Company, power owned by ... 34
Pepperell Manufacturing Company, power owned by ... 107
Petersons Rips, power at ... 75
Piscataqua River, lakes in basin of, number, area, etc., of ... 17
powers on ... 116-117
Piscataquis Falls Pulp and Power Company, power used by ... 32-33
Piscataquis River, drainage area of ... 28
lakes in basin of, area of ... 29
Pleistocene history, sketch of ... 13-15
Poland Paper Company, power used by ... 91
Pomgocwahem Lake, elevation of ... 17
Pontoocook Falls, dam at ... 76
Portage Lake, elevation of ... 17
Porter, D., work of ... 11
Pre-Pleistocene history, sketch of ... 13
Presque Isle River, power sites on ... 111
Page.
Presumpscot River, flow of ... 93-104
lakes in basin of, number, area, etc., of ... 17
map of basin of ... 70
powers on ... 91-92
rainfall in basin of, ratio of run-off to ... 104
Princeton, storage above ... 22
Princeton dam, power at ... 27
Public Work Company, power used by ... 34,35
Pulp mills, capital invested in and timber used by ... 15-16
Rainfall at Orono ... 38
at Rumford Falls ... 77-78
at Sebago Lake ... 101-104
ratio of run-off to, in Androscoggin Basin ... 78
in Cobbosseecontee Basin ... 70
in Kennebec Basin ... 57
in Presumpscot Basin ... 104
Rangeley Lakes, elevation of ... 17
Richardson Lake, elevation of ... 17
Ripogenus, arches at, view of ... 30
Ripogenus Lake, elevation of ... 17
Roach River, source and course of ... 57
Robinson Manufacturing Company, power used by ... 92
Royal River, lakes in basin of, number, area, etc., of ... 17
Rumford Falls, Androscoggin River at, flow of ... 76-91
power at ... 75-76
rainfall at ... 77-78, 85-90
views of ... 72, 74, 76
Run-off, ratio of rainfall to, in Androscoggin Basin ... 78
relation of rainfall to, in Cobbosseecontee Basin ... 70
in Kennebec Basin ... 57
in Presumpscot Basin ... 104
Schoodic Lakes, elevation of ... 17
storage in ... 22
Sebago Lake, area of ... 91
elevation of ... 17
flow of, variation in ... 19
Presumpscot River at outlet of, flow of ... 93-104
rainfall in basin of, ratio of run-off to ... 104
rainfall and run-off at ... 101-104
Sebago Wood Board Company, power used by ... 92
Sebasticook River, drainage area of ... 40
lakes in basin of, area of ... 40
powers on ... 59
Sebec Lake, elevation of ... 17
Sheepscot Falls, power at ... 115
Sheepscot River, power on ... 115
Sheeepscot and St. George rivers, lakes in basin of, number, area, etc., of ... 17
Skowhegan, power at ... 44
Skowhegan Water Power Company, power owned by ... 44
Smith, G. O., acknowledgments to ... 12
Somerset Mills, power at ... 45
Spragues Falls, power site at ... 25

Page.
Spragues Falls, view of 26
Spednic Falls, power site at 25
Square Lake, elevation of 17
Squawpan Lake, elevation of 17
Steep Falls, power at 108
Stillwater, power at 34
Stone, G. H., cited 14
Storage in Androscoggin Basin 71-72
in Kennebec Basin 40-42
in Penobscot Basin 29-30
in Saco Basin 105-106
in St. Croix Basin 21-22
in St. John Basin 110
Sunk Haze Rips, Penobscot River at, discharge of 37-38
Swain, G. F., estimates by 115
work of 11
Sysledobsis Lake, storage in 22
Saccarappa, power at 92
Saco, power at 107
Saco River, basin of, area, topography, etc., of 105
fall in 107
falls on, view of 106
lakes in basin of, number, area, etc., of 17
map of basin of 70
powers on 106-109
storage on 105-106
view of 76
Saco Water Power Company, lakes controlled by 106
power owned by 107, 108
St. Croix Log Driving Company, work of 21-22
St. Croix River, basin of, area, topography, etc., of 20-21
fall in 24
falls of, views of 26
lumbering on 21
lake storage in basin of 21-23
lakes in basin of, number, area, etc., of 17
map of basin of 20
powers on 23-27
St. Francis River, power sites on 112
St. George River, power on 115
St. George and Sheepscot rivers, lakes in basins of, number, area, etc., of 17
St. John River, artificial connection between Penobscot River and 36
basin of, area, topography, etc., of 109-110
lakes in basin of, number, area, etc., of 17
powers on 110-111
storage on 110
St. Stephen, N. B., falls at, view of 26
Salmon Falls of Saco River, power at 108
view near 76

Page.
Salmon Falls of St. Croix River, power at 26
view of 26
Sandy River, drainage area of 40
lakes in basin of, area of 40
powers on 58
Temperature. *See* Climate.
Thatcher, B. B., & Co., power used by 33
Ticonic Falls, power at 45
Tidal powers, discussion of 117
Timber, growth of 16
Todd, F., power owned by 27
Twin dam, storage at 30
Twombly, A. H., information furnished by 59
Umbagog Lake, elevation of 17
Umbagog Pulp Company, power used by 75
Union Falls, power at 108
Union Gas and Electric Company, power used by 59
Union River, lakes in basin of, number, area, etc., of 17
powers on 114-115
Union Water Power Company, dam of 71
power owned by 74-75
Vanceboro, storage above 22
Varney Falls, power site at 116
Veazie, power at 32, 34
Walker, J., & Co., power used by 34
Warren, J. A., cited 92
Warren, S. D., & Co., aid by 93
power used by 92
Waterville, Kennebec River at, discharge of 47-57
power at 45
rainfall and run-off at 52-57
Water wheels, number in use 119
Water surface, area of 15
Webster, power at 34
Wells, W., cited 23
work of 11
Wesserunsett River, lakes in basin of, area of 40
West Branch of St. Croix River, power on 27
West Machias River, power sites on 113
Westbrook Electric Light and Power Company, power used by 92
Westbrook Manufacturing Company, power used by 92
Whitney, power site at 113
Williams, H. S., and Gregory, H. E., cited 13
Winn, power site at 32
Winslow, power at 45
Wood Lake, elevation of 17
Woodland, area of 15
Worumbo Manufacturing Company, power used by 74
York Manufacturing Company, power owned by 107

O

Clemson College Library

19.13 70
GOVERMENT PUBLICATIONS

DEPARTMENT OF THE INTERIOR

WATER-SUPPLY

AND

IRRIGATION PAPERS

OF THE

UNITED STATES GEOLOGICAL SURVEY

No. 70

GEOLOGY AND WATER RESOURCES OF THE PATRICK AND GOSHEN HOLE QUADRANGLES, WYOMING-NEBRASKA.—ADAMS

WASHINGTON
GOVERNMENT PRINTING OFFICE
1902

IRRIGATION REPORTS.

The following list contains titles and brief descriptions of the principal reports relating to water supply and irrigation prepared by the United States Geological Survey since 1890:

1890.

First Annual Report of the United States Irrigation Survey, 1890; octavo, 123 pp.

Printed as Part II, Irrigation, of the Tenth Annual Report of the United States Geological Survey, 1888-89. Contains a statement of the origin of the Irrigation Survey, a preliminary report on the organization and prosecution of the survey of the arid lands for purposes of irrigation, and report of work done during 1890.

1891.

Second Annual Report of the United States Irrigation Survey, 1891; octavo, 395 pp.

Published as Part II, Irrigation, of the Eleventh Annual Report of the United States Geological Survey, 1889-90. Contains a description of the hydrography of the arid region and of the engineering operations carried on by the Irrigation Survey during 1890; also the statement of the Director of the Survey to the House Committee on Irrigation, and other papers, including a bibliography of irrigation literature. Illustrated by 30 plates and 4 figures.

Third Annual Report of United States Irrigation Survey, 1891; octavo, 576 pp.

Printed as Part II of the Twelfth Annual Report of the United States Geological Survey, 1890-91. Contains "Report upon the location and survey of reservoir sites during the fiscal year ended June 30, 1891," by A. H. Thompson; "Hydrography of the arid regions," by F. H. Newell; "Irrigation in India," by Herbert M. Wilson. Illustrated by 93 plates and 190 figures.

Bulletins of the Eleventh Census of the United States upon irrigation, prepared by F. H. Newell; quarto.

No. 35, Irrigation in Arizona; No. 60, Irrigation in New Mexico; No. 85, Irrigation in Utah; No. 107, Irrigation in Wyoming; No. 153, Irrigation in Montana; No. 157, Irrigation in Idaho; No. 163, Irrigation in Nevada; No. 178, Irrigation in Oregon; No. 193, Artesian wells for irrigation; No. 198, Irrigation in Washington.

1892.

Irrigation of western United States, by F. H. Newell; extra census bulletin No. 23, September 9, 1892; quarto, 22 pp.

Contains tabulations showing the total number, average size, etc., of irrigated holdings, he total area and average size of irrigated farms in the subhumid regions, the percentage of number of farms irrigated, character of crops, value of irrigated lands, the average cost of irrigation, the investment and profits, together with a résumé of the water supply and a description of irrigation by artesian wells. Illustrated by colored maps, showing the location and relative extent of the irrigated areas.

1893.

Thirteenth Annual Report of the United States Geological Survey, 1891-92, Part III, Irrigation, 1893; octavo, 486 pp.

Consists of three papers: "Water supply for irrigation," by F. H. Newell; "American irrigation engineering" and "Engineering results of the Irrigation Survey," by Herbert M. Wilson; and "Construction of topographic maps and selection and survey of reservoir sites," by A. H. Thompson. Illustrated by 77 plates and 119 figures.

A geological reconnoissance in central Washington, by Israel Cook Russell, 1893; octavo, 108 pp., 12 plates. Bulletin No. 108 of the United States Geological Survey.

Contains a description of the geologic structure in and adjacent to the drainage basin of Yakima River and the great plains of the Columbia to the east of this area, with special reference to the occurrence of artesian waters.

1894.

Report on agriculture by irrigation in the western part of the United States at the Eleventh Census, 1890, by F. H. Newell, 1894; quarto, 283 pp.

Consists of a general description of the conditon of irrigation in the United States, the area irrigated, cost of works, their value and profits; also describes the water supply, the value of water, of artesian wells, reservoirs, and other details; then takes up each State and Territory in order, giving a general description of the condition of agriculture by irrigation, and discusses the physical conditions and local peculiarities in each county.

Fourteenth Annual Report of the United States Geological Survey, 1892-93; Part II, Accompanying papers, 1894; octavo, 597 pp.

Contains papers on "Potable water of the eastern United States," by W J McGee; "Natural mineral waters of the United States," by A. C. Peale; and "Results of stream measurements," by F. H. Newell. Illustrated by maps and diagrams.

(Continued on third page of cover.)

DEPARTMENT OF THE INTERIOR

WATER-SUPPLY

AND

IRRIGATION PAPERS

OF THE

UNITED STATES GEOLOGICAL SURVEY

No. 70

WASHINGTON
GOVERNMENT PRINTING OFFICE
1902

UNITED STATES GEOLOGICAL SURVEY

CHARLES D. WALCOTT, DIRECTOR

GEOLOGY AND WATER RESOURCES

OF THE

PATRICK AND GOSHEN HOLE QUADRANGLES

IN

EASTERN WYOMING AND WESTERN NEBRASKA

BY

GEORGE I. ADAMS

WASHINGTON

GOVERNMENT PRINTING OFFICE

1902

CONTENTS.

	Page
Letter of transmittal	9
Introduction	11
Area described	11
General statement	11
Geology	13
General geology of the region	13
Description of formations	14
Cretaceous	14
Laramie formation	14
Tertiary	15
Chadron formation	15
Brule formation	16
Arikaree formation	16
Ogallala formation	18
Surficial deposits	19
Mantle of detritus	19
Alluvium	20
Stream gravels from outside areas	20
Stream gravels of local origin	20
Terrace gravels from disintegration in place	21
Sand hills or dunes	22
Surface features	22
General relations and elevations	22
Goshen Hole escarpment	23
Upland	23
Lowland	23
Water supply	25
Streams	25
Springs	27
Ponds	28
Wells	29
Artesian wells	30
Irrigation	31
Little Horse Creek ditches	32
Horse Creek ditches	32
Bear Creek ditches	32
Fox Creek ditches	32
Rawhide Creek ditches	33
Platte River ditches	33
Timber, grass, and agricultural products	34
Timber	34
Grasses	35
Herbaceous plants	36
Agricultural products	36

	Page.
Settlement and occupancy of public lands	37
Early settlement relative to water for stock	37
Entry of lands under the desert-lands act	38
Construction of reservoirs on public lands for watering live stock	40
Entry of lands under the homestead, preemption, timber-culture, timber and stone, and other acts	40
Occupancy of land not naturally watered	40
Appendix	42
Desert-lands act	42
Carey act	44
An act providing for the construction of reservoirs on public lands for watering live stock	46
Index	49

ILLUSTRATIONS.

Page

PLATE I. View from the head of Box Elder Canyon, looking from the upland into the Goshen Hole lowland 12

II. General geological map of the region along the North Platte River, near the Wyoming-Nebraska line 14

III. Map showing the geology of the Patrick and Goshen Hole quadrangles 16

IV. *A*, Chadron sandstone near Box Elder Creek, west end of Goshen Hole; *B*, Laramie beds northwest of Hawk Springs 18

V. *A*, View of the west end of 66 Mountain; *B*, Eagle Rock at Fox Creek Gap 20

VI. *A*, Point of Rocks, east of Snow's ranch, showing conglomerate near the base of the Arikaree formation, with the Brule clay below; *B*, Gravel terrace formed by the disintegration of the conglomerate west of Rawhide Creek, near its junction with the North Platte 22

VII. *A*, Sandstone dike cutting the Arikaree formation northeast of Pine Ridge; *B*, Sandstone dike cutting the Arikaree formation on Dry Rawhide Creek 24

VIII. Map showing cultivated land under irrigation and distribution of timber 32

IX. *A*, Bear Creek Mountain, looking eastward, with alfalfa field and Meriden post-office in the foreground; *B*, Eagle Rock and Lone Rocks at Fox Creek Gap, in Arikaree formation 34

X. *A*, Goshen Hole escarpment and Chimney Rock, Trelona post-office in the foreground; *B*, Water hole and cattle, Goshen Hole lowland 36

XI. Map showing classes of entries of public lands and State selections 40

FIG. 1. Map showing geographic relations of the Patrick and Goshen Hole quadrangles 12

2. Sketch showing the west end of Goshen Hole, the Goshen Hole escarpment and Laramie Mountains in the distance 22

3. Sketch of Bear Creek Mountain and Fox Creek Gap 24

4. Map showing constructed and proposed canals along the North Platte River 33

LETTER OF TRANSMITTAL.

DEPARTMENT OF THE INTERIOR,
UNITED STATES GEOLOGICAL SURVEY,
Washington, D. C., May 15, 1902.

SIR: I have the honor to transmit herewith a manuscript by Mr. George I. Adams, assistant geologist of this Survey, upon the geology and water resources of a portion of eastern Wyoming and western Nebraska, and to request that it be published in the series of Water-Supply and Irrigation Papers. The field work upon which this is based was done during August and September, 1901. The report, while largely geologic in character, deals with some of the problems of water supply for this area and discusses conditions which are to be found over a considerable part of the public-land area. For this reason it is desirable to print the paper at the present time, while these matters are being discussed by the public.

Very respectfully,

F. H. NEWELL,
Hydrographer in Charge.

Hon. CHARLES D. WALCOTT,
Director of United States Geological Survey.

GEOLOGY AND WATER RESOURCES OF THE PATRICK AND GOSHEN HOLE QUADRANGLES, IN EASTERN WYOMING AND WESTERN NEBRASKA.

By George I. Adams.

INTRODUCTION.

Area described.—The area discussed in this report lies for the most part in eastern Wyoming, but includes on its eastern border a narrow strip of Nebraska, about 2½ miles wide. It has a width of approximately 25 miles from east to west and a length of 68 miles from north to south, and is bounded by meridians 104° and 104° 30′ and parallels 41° 30′ and 42° 30′. It constitutes, accordingly, two quadrangles—i. e., two of the units employed in topographic and geologic mapping by the Geological Survey—each one-half a degree square. The northern of these is the Patrick quadrangle and the southern the Goshen Hole. The longitude of the meridians which bound the quadrangles is reckoned from Greenwich. The boundary line between Nebraska and Wyoming is meridian 27° west reckoned from Washington, which falls west of meridian 104° from Greenwich, and the portion of Nebraska here described lies between these two lines. The accompanying sketch map (fig. 1) shows the geographic relations of the area.

General statement.—The Patrick and Goshen Hole quadrangles lie in that portion of the semiarid region of the Great Plains plateau which has presented peculiar and difficult problems to those who have attempted to settle it and utilize its natural resources. The country is best adapted to grazing. Experience has shown that crops can be grown without the aid of irrigation only in exceptional years or in favored localities. In the absence of irrigation enterprises the lands were left to the use of ranchmen, who, enjoying the advantage of a wide and free range, were able to depend upon the grass and the limited natural meadows for the support of their herds. In the earlier days of occupancy the lands for which titles were obtained were practically only such as were necessary for home ranches. The locations were widely separated and usually were chosen relative to a stream, spring, timber, natural meadow, or shelter. On the passing of the

"desert-lands act," providing for the sale of lands reclaimed by irrigation, a new factor entered. The lands to which water could be conducted lay along the streams, and ownership of them brought with it the exclusive use of the streams for the watering of stock. In view of the crowding of herds this privilege was very desirable, since it made possible the controlling of the range. The construction of irrigation ditches presented no special difficulties, and was largely done by those

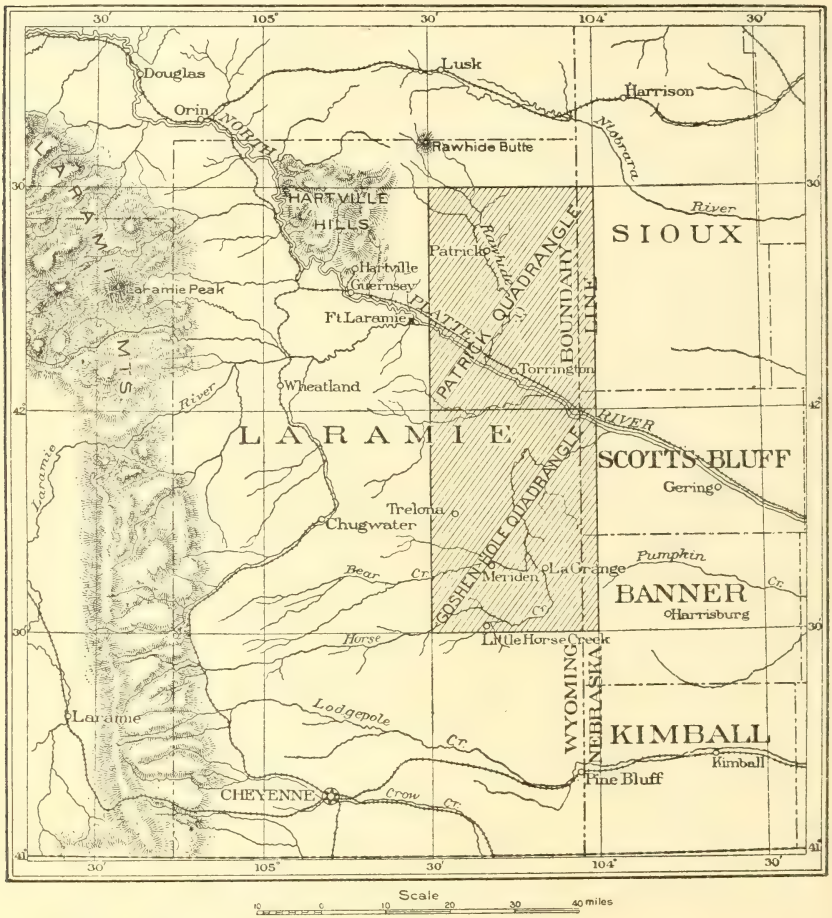


FIG. 1.—Map showing geographic relations of the Patrick and Goshen Hole quadrangles.

interested in stock raising. Many of the ditches paralleled the streams, and the water, not being easily conducted far from the valleys, was carried as far as possible along them. In a short time so much land had been entered under the desert-lands act that a ranchman desiring to establish himself was obliged to first find open water.

The lands irrigated consisted chiefly of natural meadows or fields of alfalfa. With the exception of the Platte River all the available water was in a short time appropriated, and in many cases ditches

VIEW FROM THE HEAD OF BOX ELDER CANYON LOOKING FROM THE UPLAND INTO THE GOSHEN HOLE LOWLAND

were constructed which were never of practical benefit, except in obtaining titles to the lands before the rulings by the General Land Office required their actual reclamation. The irrigation now being conducted is principally for the purpose of raising hay and forage, which is used as winter feed. This permits of a much greater number of cattle being grazed, since it reduces the amount of grass which must be reserved for winter pasture.

With the taking up of the lands, so that but little "open water" remained, the ranchmen were enabled to utilize the remaining portion for grazing, and, having made mutual agreements, felt in a measure secure, and even ventured to fence public lands which they wished to reserve for their own use. Lately the sinking of deep wells and the use of windmills and gasoline engines for pumping has developed a new situation. The leasing of a small tract of State lands or the entry of public lands and the maintenance of a watering place in this manner has enabled the ranchmen to establish themselves in the open range, and the gradual crowding is resulting in the disappearance of illegal fences. There is little hope that the country will be thickly settled except in such localities as can be irrigated, because of the fact that very large tracts are required for grazing, a common estimate being that 20 acres per head is necessary for summer and winter pasturage. Enterprises which are now being promoted are in accordance with the Carey act. Under its provisions the land must be actually reclaimed, and this is possible with only a small percentage of the area. There is at present a feeling that some arrangement should be made which would insure the rightful and exclusive use of the grazing lands of the public domain, and the question of the Government's leasing them is receiving consideration. In the following discussion the general character of the country, soil and rock formations, grazing industry, surface features, water supply, irrigation enterprises, and settlement and occupancy are reviewed and discussed.

GEOLOGY.

GENERAL GEOLOGY OF THE REGION.

The formations represented in the region under consideration are broad sheets of rocks which extend from the foothills of the mountains eastward onto the Great Plains plateau and have a dip that is a little less than the grade of the surface. They consist of two series, differing materially in character and having discordant relations. The older formations consist of Cretaceous rocks and their substructure of Paleozoics, which were deposited before the present ranges of the Rocky Mountains were developed. They have been flexed upward along the foothills by the movements which accompanied the mountain making, and their edges outcrop in narrow belts parallel to the mountains. Although the thickness of these rocks is thousands of

feet, they may be passed over in a short distance where they abut against the igneous and metamorphic rocks of the mountain ranges and have steep dips. In the portion of the plains here described the rock sheets are nearly horizontal, and the individual formations have a wide extent. The younger and higher ones only are reached in the deep borings and are found as surface outcrops. In the accompanying map (Pl. II) the general geology of the region is shown. The area in which the older rocks are seen as a result of the mountainous structure is the Hartville Hills. The horizontal portion of the older rocks, which is generally embedded, appears at the surface in the locality of Goshen Hole and the lower valley of Horse Creek, where, as a result of the removal of the younger series, the Laramie Cretaceous is exposed.

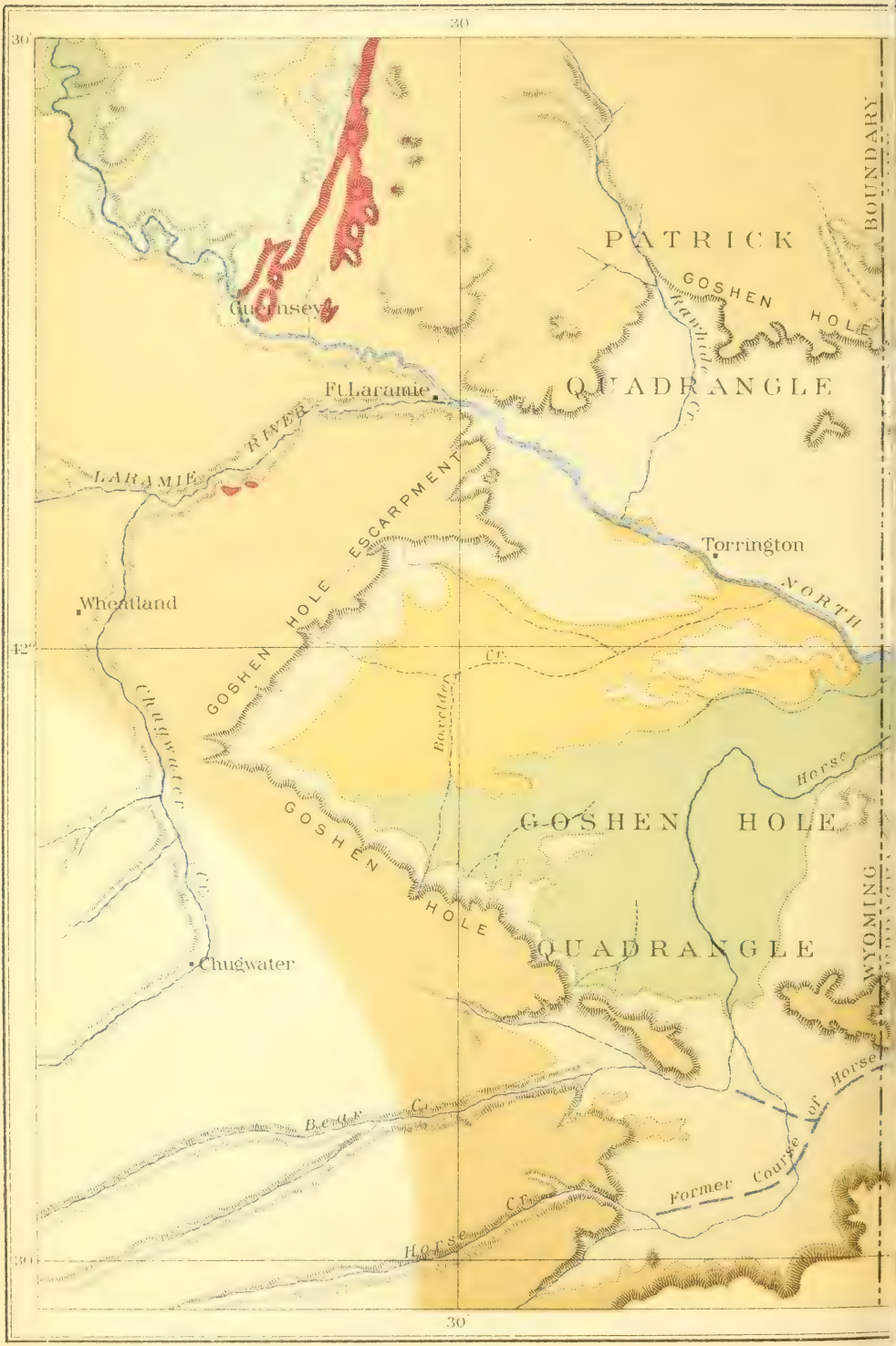
Lying on the floor of older rocks is the Tertiary series, which has been spread over them as sheets of clay and sand, extending from the mountains toward the plains with diminishing thickness. The source of this material was evidently the mountain region to the westward, which was elevated at the beginning of Tertiary time, and in which the rapid disintegration of the rocks under the processes of erosion furnished sediments for the younger series. The Tertiary formations of this portion of the country bear evidence, in the character and distribution of materials as well as in the fossil remains which are found in them, of having been deposited upon the surface of the continent principally through the agency of fresh water. The formations overlap one another toward the mountains and formerly extended farther upon their flanks, the zone of deposition seemingly having migrated toward the mountains as time progressed.

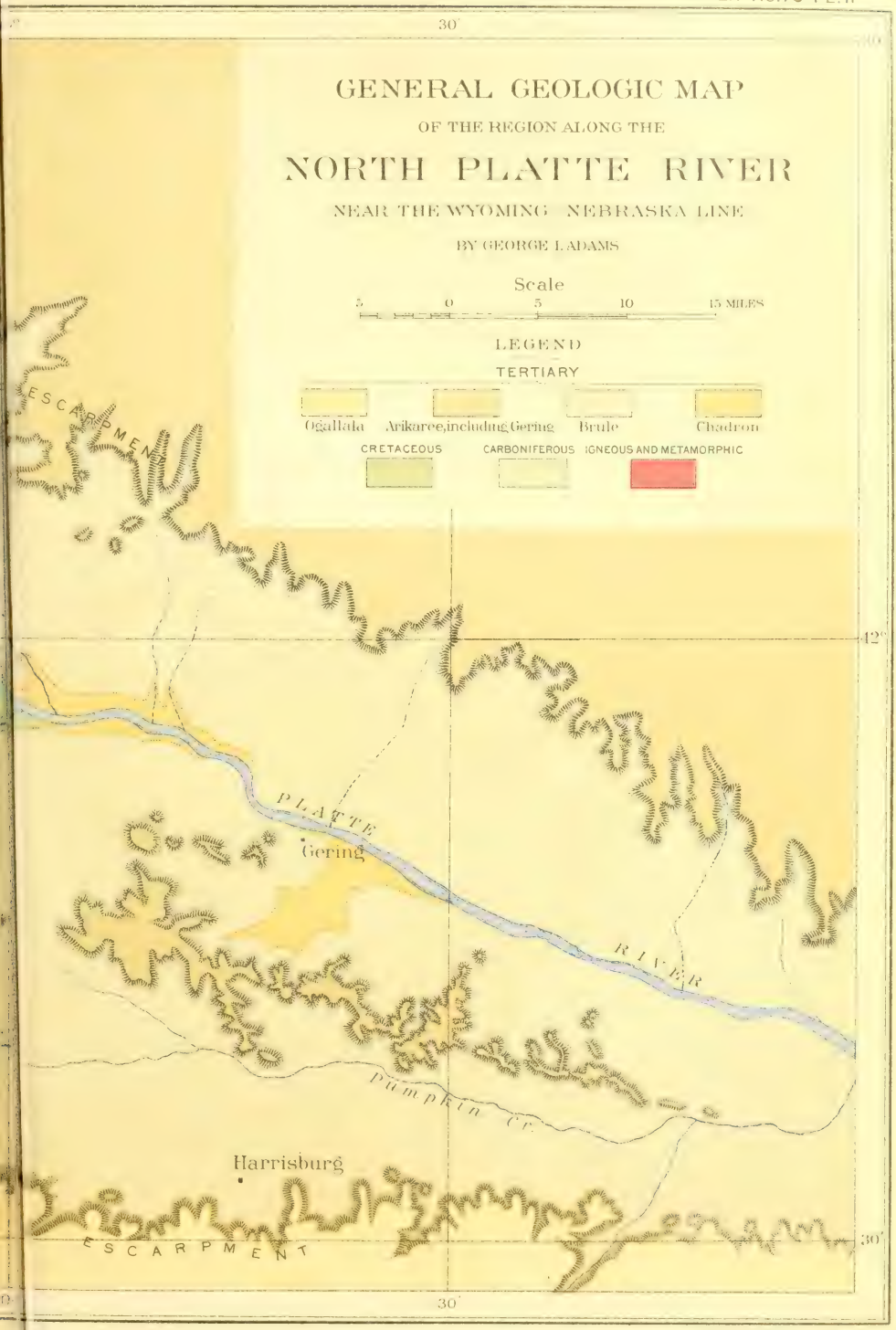
In recent times destructional processes have been operative and the Tertiary has been largely eroded, so that in places its upper divisions are worn away, and in the locality of Goshen Hole and near the mouth of Horse Creek the beds have been completely removed, revealing the underlying Cretaceous.

DESCRIPTION OF FORMATIONS.

CRETACEOUS.

Laramie formation.—This formation has but a limited occurrence, and the outcrops are largely concealed by surficial deposits (see Pl. III). It consists of yellowish and greenish sands, variegated clays, and local beds and lenses of a bluish siliceous limestone, which upon weathering breaks into irregular fragments and has a yellowish color. The sands are cross bedded and current bedded and form a friable sandstone which disintegrates readily and suffers erosion through the agency of wind. The limestones and certain indurated sands which are well cemented appear as bowlders in some of the outcrops (see


30'
PATRICK
BOUNDARY
GOSHEN
HOLE
Rawhide
Cr.
QUADRANGLE
Guernsey
Ft. Laramie
LARAMIE
RIVER
ESCARPMENT
Torrington
NORTH
Wheatland
42°
GOSHEN
HOLE
Cr.
Boreldes
Chugwater
Horse
GOSHEN
HOLE
GOSHEN
HOLE
QUADRANGLE
WYOMING
Chugwater
Cr.
Cr.
Former Course of Horse
Cr.
Horse
30'
30'



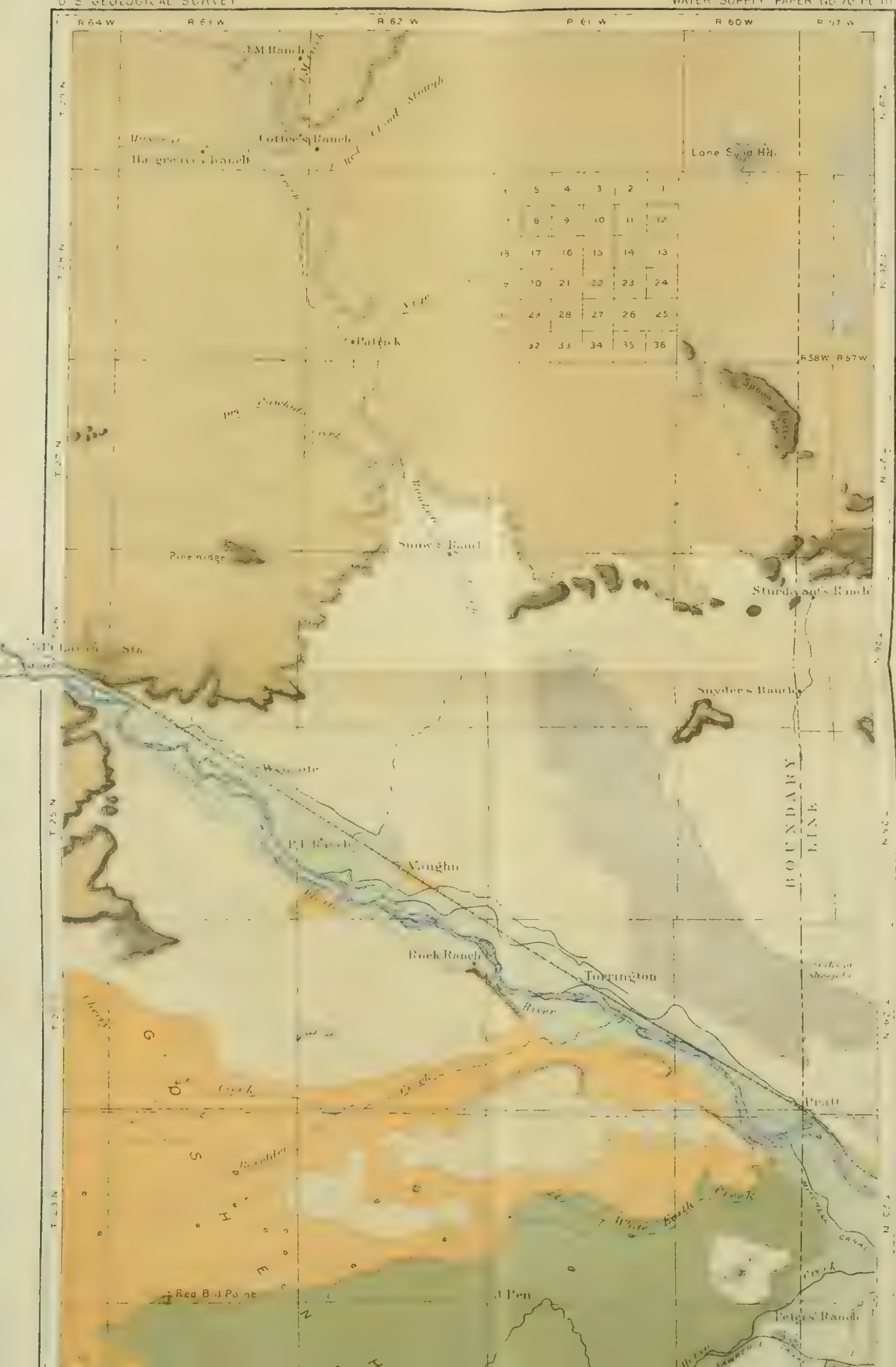
JULIUS BIEN & CO LITH. N.Y.

number of low points which are capped by remnants of these sandstones. The most conspicuous among them for its altitude is Red Bill Point, although there are a number of ridges of greater extent. Along the Platte River, in the absence of better building stone, these beds have been quarried where they are of fairly uniform texture, and supply a durable stone, although it is difficult to work. This formation appears to have been limited southward by a Cretaceous ridge, outcrops of which are seen in the southern part of Goshen Hole. The area of Chadron shown on the map is confined wholly to the north slope of this ridge, if such it be, and south of it the formation evidently is absent.

Brule formation.—Succeeding the Chadron beds and lying unconformably upon them, or in their absence upon the Cretaceous, is a thick mass of clay which has very uniformly a pinkish or flesh-colored tint, except at some localities of limited area, where its basal portion assumes a varying phase. In these places it is a whitish clay having grayish and greenish tinges, with a thin bed of white limestone of particularly uniform character occurring in the locality of Table Mountain and the elevated point 3 miles north of it and in the small knobs 2½ miles north of Trelona. The pink clay is generally homogeneous in character, seldom containing conglomeratic beds. These occur, however, in limited areas, but are usually composed of small gravels. They are not found at any particular horizon, but appear to represent local current phases of deposition.

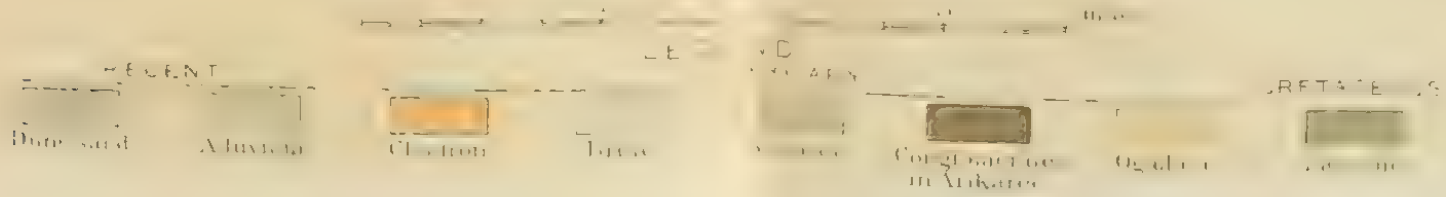
The Brule clay weathers readily and is transported over the slopes, where the wash from it forms a thin, pinkish veneer. Where it occurs in vertical walls as a result of the protecting cap of higher beds, or in small knobs and points, it is usually quite destitute of vegetation and is seen to have a jointed structure, and a slight deposit of limy material is often present along the joint planes. In weathering, these joint planes are often made bare by the removal of angular fragments and give the surface an exfoliated appearance. The limestones above mentioned are the only beds which determine in any way definite erosional forms, and they give rise to table-like hills in which the limestone is nearly at the summit. In the absence of better material the stone has been quarried and used in building, although it supplies only slabby material a few inches in thickness.

Arikaree formation.—The Arikaree formation represents a decided change in the character of sediments from those which were deposited in the time of the Brule. Instead of clay the material consists almost wholly of sands, which were deposited unconformably upon the older beds. The Arikaree sand is slightly cemented, so that it forms a protecting cap to the underlying formations, and it occurs frequently in the escarpments of the region (see Pl. V). It has several phases, which range both horizontally and vertically through its extent. The simplest of these is homogeneous sand without any distinctive struc-


R 64 W
R 63 W
R 62 W
R 61 W
R 60 W
R 57 W
R 58 W
T 28 N
T 27 N
T 26 N
T 25 N
T 24 N
T 23 N
J M Ranch
Cottier's Ranch
Lone Sand Hill
Pattick
Spoon Butte
Pine ridge
Snow's Ranch
Sturdevant's Ranch
Snyder's Ranch
BOUNDARY LINE
Vaughn
Rock Ranch
Torrington
Pratt
Red Bluff Point
Peters' Ranch

MAP SHOWING GEOLOGY OF THE PATRICK AND GOSHEN HOLE QUADRANGLES

BY [illegible] ADAMS



ture, but having the peculiarity of weathering in vertical columns or walls. Another phase is that in which concretions occur, usually of a tabular or pipy form, with an occasional development of nodules having a vertical position in the beds. The concretions are of sandstone, well cemented. On weathering they form projecting points and lenses in the vertical walls and ledges and protecting caps on the pinnacles. They give bizarre forms to the pinnacled and chimney rocks which are so common throughout the area of the formation. Another phase of the Arikaree are the conglomeratic beds, which represent channel or current deposits and which occur at varying horizons (see Pl. VI, *A*). These are commonly found at the base of the formation where it is in contact with the Brule clay, and show the unconformable relations of the two deposits resulting from contemporaneous erosion and deposition. The individual lenses vary in thickness, and at any particular locality the variation extends from a few feet to 200 feet. The fact that this phase is present at the base of the Arikaree does not necessarily indicate that it was deposited contemporaneously, since it is probable that the conglomerates were deposited as the sediments encroached upon the higher levels. Their occurrence in the upper horizons is due to the later oscillation of the channels as the thickness of the sediments increased. On the geologic map this phase has been represented and to it has been given the name Conglomeratic beds in the Arikaree. These may not represent a formation in the sense that the Gering does, although the beds differentiated as such in the country to the east, on the south side of the Platte Valley, are in every way similar. The relation of these lenses is best seen in the locality of Spoon Butte, in the Patrick quadrangle, and for a short distance to the south. In the escarpment and lone hills north of Sturdivant's ranch, conglomerates are seen resting on Brule clay, or separated from it by a very thin bed of Arikaree sand. In Spoon Butte the lenses are coarse sandstones exhibiting a cross-bedded structure, and their occurrence is 400 feet above the lowest exposed portion of the Arikaree. In the intermediate localities the lenses occur at somewhat lower horizons and seem to justify perfectly the interpretation here placed upon them. In Pine Ridge and the small knobs near the eastern border of the Patrick quadrangle there is a conglomerate which does not now have a very wide extent, since it occurs on the tops of these hills.

The gravels and materials that constitute the conglomeratic lentils contain many varieties of rocks which are found in the Rocky Mountain region. They vary in size from small, much-worn fragments up to bowlders, and are cemented in a matrix of sand. The disintegration of this conglomerate has given rise to terraces which maintain their form as a result of the heavy deposit of gravel lying upon them (see Pl. VI, *B*). These terraces occur at levels somewhat lower than the conglomerate beds, and the connection between the two may be readily

seen by tracing the material from the ledge past the talus slopes to the veneering of gravel. An example of such a terrace is the somewhat elevated land lying between the mouth of Rawhide Creek and the Platte River. Such terraces may be considered as indicating the former greater extent of the conglomerate beds. The transportation of these gravels has given rise to stream terraces in certain localities, and has supplied in part the gravels found in the stream channels. They are of local occurrence inasmuch as the conglomerate beds themselves are a local phase. The gravels of the stream terraces and the streams are no doubt blended with more recent gravels which have been transported from other localities. This is particularly true along the Platte River and the streams heading in the foothills and mountains.

In the Arikaree there are narrow sandstone dikes which on weathering protrude above the surface and are conspicuous because of the comb-like structure which they have when the adjacent formation weathers away (see Pl. VII). They were noted northeast of Pine Ridge and west of Spoon Butte. They have a strike N. 20° to 30° E., and apparently have been developed along fractures, which have been produced by some general cause. Those which occur northeast of Pine Ridge are the more important and can be seen for several miles, although possibly the outcrops do not belong to the same dikes at the different localities. They extend as far as Patrick, where they may be seen on either side of the valley of Rawhide Creek, in the crests of the hills. The material which constitutes the dikes is principally sand, with some infiltered calcareous material. On weathering the calcareous matter has a honeycombed appearance, the loosely cemented sand disappearing. The width of the dikes is only a few feet, sometimes only a few inches. Those west of Spoon Butte extend for short distances and are relatively narrow. The direction of the dikes is approximately parallel to the structure in the Hartville Hills, and it is not unlikely that they have been produced by dislocations or movements along inherent lines of weakness in the deeper formations. These dikes have attracted some attention, but an examination has shown that there is nothing to warrant prospecting in them for minerals. The material of which they are constituted has evidently been derived from the wall rock. There apparently has been some slipping and consequent slickensiding of the dike material since they were formed.

Ogallala formation.—This formation is represented in this area only in the southeast corner of the Goshen Hole quadrangle, where it occurs on the upland overlying the Arikaree. It consists of beds of sandy and calcareous material with local conglomeratic phases, developed particularly at its base. Within the area here described it does not attain its characteristic development, since but a thin remnant of it remains on the upland. The pebbles and fragments of crystalline

A. CHADRON SANDSTONE NEAR BOX ELDER CREEK, WEST END OF GOSHEN HOLE.

B. LARAMIE BEDS NORTHWEST OF HAWK SPRINGS.

rocks that are scattered through it are variable in character, and the sands it contains are cemented by carbonate of lime, which in places develops into what are known as mortar-bed ledges. It contains considerable clay or marl, which has a slightly creamy or pinkish color. Not uncommonly this formation is called "magnesia," although the word here is a misnomer if it signifies that the formation is magnesian. South of the valley of Horse Creek the Ogallala extends farther westward. Its principal area, however, is in Nebraska, northeastern Colorado, and the northwest corner of Kansas.

SURFICIAL DEPOSITS.

Mantle of detritus.—In this region disintegration is more active than transportation, so that there has accumulated a considerable veneering of surficial material. It consists of sand and clay mingled with humus from the decaying vegetation. This material is found to grade from coarse talus adjacent to the cliffs into slope wash, and in places it is a soil which is firmly held by the sod. It has resulted from gravitative action, solution and transportation by water, and the eroding and carrying power of the wind. The materials are largely derived from the rocks of the area. The sand is from the Arikaree, Chadron, and Laramie formations, while the clay is principally the result of disintegration of the Brule. The gravels are from the breaking down of local conglomerates, and in part are brought into the region by the streams. At many places they are so intermingled that they can not be mapped separately.

During the dry season the surface mantle of sand and clay is transported by the wind in its prevailing direction and accumulates on the higher places. At times of flood the material is carried down the slopes and transported along the valleys by the storm water. When the creeks flow with large volume they carry the accumulated sands and spread them along their courses, but this material does not form alluvium, since it is not stratified, but is simply dropped where the current is retarded. Moreover, its position is not permanent, since when it dries it may be swept away by the wind, or a succeeding cloudburst may transport it farther. Inasmuch as the wind and run-off waters in the sum total of their activities are about balanced, the surficial materials oscillate in their position between the condition of wind-blown accumulations on the ridges and surface wash on the slopes and in the valleys. Finally, however, they are either transported down the streams or lodge in the sand hills, where they are held by the vegetation.

The mantle of unconsolidated detritus apparently dates back to the time when the region was occupied by primitive horses and elephants, and accordingly it is in part early Pleistocene. The material at the places where these fossils have been found is, however, not essentially different from that which has but recently been deposited.

Accordingly, no attempt is made to classify these deposits. Moreover, their thickness is exceedingly variable and is frequently disguised by the even covering of sod. They range from a thin veneer of clay to beds of slope wash as much as 50 feet thick. The accumulations of sand at some of the localities mapped as dunes rise fully 100 feet above the general level of the older formations.

Alluvium.—The only area in which alluvium is shown on the accompanying map is the recent flood plain of Platte River. The deposit consists of silt and the sediment from the stream, with which is mingled considerable gravel. Where the river enters the Patrick quadrangle through the narrows the valley floor is about a mile wide. Below this point it is not restricted by bluffs. In the vicinity of the P. F. ranch and Torrington it is about 3 miles wide. The channel of the Platte is broad and is occupied by sand bars and islands, and evidently has shifted frequently. The alluvial deposits do not differ in any way from the material now carried by the river. Although they are loose, and frequently sandy and gravelly, they are relatively fertile and furnish the most valuable agricultural lands because of their proximity to the source of water for irrigation. Nearly all of this land is now under irrigation ditches.

It might seem that the larger streams tributary to the Platte would be bordered by alluvium. No such deposits have been mapped, and it is questionable whether they should be distinguished, for the reason that the streams are not bordered by true flood-plain deposits. They flow only in certain seasons of the year, and when they carry their largest volume of water the material transported is that which is washed from the slopes by the cloudbursts and heavy rainfall, and consists of the loose sand and clay which are described above as eolian and creep deposits and surface wash. Moreover, along the valleys of these streams the country rock is exposed at many places within their channels.

Stream gravels from outside areas.—Except in the case of the Platte River, which has its source in the mountains, the streams do not carry a large amount of gravel. When the Platte is at low stages its bed not uncommonly appears to be paved with cobblestones. These pebbles and bowlders, on examination, are found to represent a great variety of rocks such as are found in the mountains to the west. No doubt when the river flowed at former grades it transported these materials and deposited them in terraces. At some places the river terrace gravels may be seen covering the surface, but usually they have been transported by the erosion of sand and clay and gravitative action, so that the terrace feature is obscured. Moreover, there are other gravels which are not unlike them, and it is therefore difficult to distinguish the river gravels as a distinct class of deposits.

Stream gravels of local origin.—The conglomerate beds which occur at the base of the Arikaree and locally at higher horizons within that formation have already been described. The gravels which consti-

A. WEST END OF 66 MOUNTAIN.

B. EAGLE ROCK AT FOX CREEK GAP.

tute them are not unlike the gravels which have been transported from the Rocky Mountain region, and upon the disintegration of the conglomerate they are transported by the streams and distributed along the valleys tributary to the Platte, so that they blend with the gravels of Platte River. Evidently they were derived from about the same classes of rocks, and possibly from the same general area in the Rocky Mountains. The conglomerates which are now present and exposed within the quadrangles may readily be seen to be the source of these gravels. The gravels, however, have a wider extent than is consistent with their derivation from the areas within which the conglomerates are now found. In the absence of any other source for the stream gravels it is natural to conclude that they indicate a former wider extension and occurrence of the conglomerate beds. It is altogether probable that the exposures which have been referred to as basal beds of the Arikaree were continuous between the areas where they are now found in place, and the breaking down of such a deposit would have furnished a large quantity of bowlders and gravel.

In the valley of Horse Creek and its former extension into Pumpkin Creek there are stream gravels which do not seem to have been derived from conglomerate beds within the area here described. On the general map it will be seen that the drainage of Horse Creek heads at the base of the Laramie Mountains, and it is not improbable that the gravels which occur along its valleys are derived from localities near its source. In that case they would sustain the same relation to this area which the Platte River gravels sustain, and by their occurrence in terraces they would indicate the former grades of the streams.

Terrace gravels from disintegration in place.—Adjacent to the beds of conglomerate there are gravel terraces which in certain localities have a considerable extent. They have originated through the breaking down of the conglomerate, and retain their form because the gravels make a protecting mantle. The best example of this occurrence of gravel terraces is on the point or divide between the lower part of Rawhide Creek and the Platte River. The source of the gravels may be seen in a ledge which is conspicuous to the west of the terrace and which occurs somewhat higher. Another example of this class of gravel terrace may be seen south of the Platte, on the high point to the east of the conglomerate beds which occur in the southeast corner of the Patrick quadrangle.

Where the conglomerates have been so largely removed that the relation between the gravels and the original beds is not clearly traceable, this type of deposit is not so readily distinguished. Moreover, when there has been a sufficient period of erosion to accomplish this removal, the gravels on the terraces have likewise suffered gravitative action, and occur as an indefinite deposit blending with the stream gravels and the detritus of the valley slopes. Accordingly there are

localities in which the stream gravels and the terrace gravels are indistinguishable.

Sand hills or dunes.—There is more or less sand and wind-blown material distributed over nearly the entire area which is here discussed. The source of the wind-blown sand is principally the Arikaree formation, which consists of sand only slightly cemented, and which upon weathering disintegrates into easily-transported material. Within the area designated as sand hills on the map this drifting material has accumulated into dunes. Some of the sand hills are sodded over and may be spoken of as inactive. In others the sand is constantly shifting. When for any reason the sod on a sand hill is removed or broken, the hill immediately begins to change its form and shift its position according to the direction of the wind. In Nebraska the sand hills are much more extensive than in Wyoming. Those which are seen in the Patrick quadrangle are at the western end of what is known as the great sand-hill area in Nebraska.

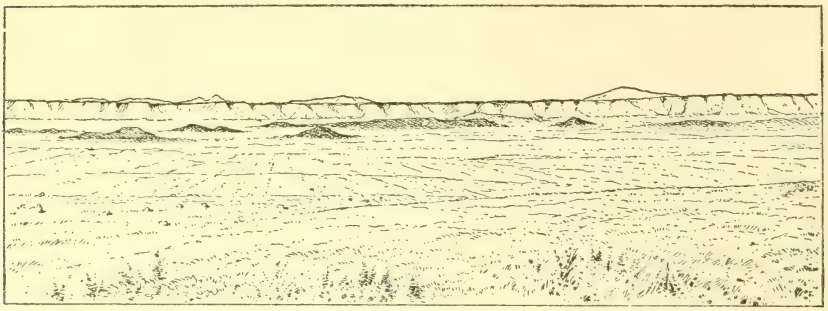


FIG. 2.—Sketch showing the west end of Goshen Hole, the Goshen Hole escarpment and the Laramie Mountains in the distance.

A considerable portion of the sand which forms dry bars in the Platte River is blown onto the upland. In this way the material transported into the area by that stream is contributed to the surficial deposits during the dry season. The sand hills north of Torrington and Pratt may be in part the result of this action.

SURFACE FEATURES.

General relations and elevations.—The region is a portion of the Great Plains plateau, which extends from the Rocky Mountains eastward, sloping gradually toward the Mississippi Valley. The Laramie Mountains lie 40 miles west of the border of the area described, and on a clear day Laramie Peak and some of the lesser peaks are visible on the horizon (see fig. 2). To the northwest, and but a short distance from the Patrick quadrangle, are the Hartville Hills and the lone point known as Rawhide Butte. The elevations within the quadrangles vary from 3,920 feet in the river valleys to 5,300 feet on the highest points.

A. POINT OF ROCKS, EAST OF SNOW'S RANCH.

Shows conglomerate near the base of the Arikaree formation, with Brule clay below.

B. GRAVEL TERRACE FORMED BY THE DISINTEGRATION OF THE CONGLOMERATE, WEST OF RAWHIDE CREEK, NEAR ITS JUNCTION WITH THE NORTH PLATTE.

Goshen Hole escarpment.—The formations which outcrop within the area consist largely of clays and sandstones which yield readily to erosion, and in some cases have the peculiarity of forming nearly vertical walls. A conspicuous feature of the region is an escarpment which forms the western border of Goshen Hole. (See Pl. I.) It is represented more or less regularly to the north of the Platte in the bluffs which extend from the vicinity of the Narrows, below Fort Laramie, in an irregular line north of Snow's ranch and Sturdivant's ranch. Bear Creek Mountain and 66 Mountain (see Pls. V, A and IX, A), in the southeastern part of the area mapped, are isolated portions of this escarpment, which is found continuous again from the southeast corner of the Goshen Hole quadrangle into Nebraska. This escarpment may be regarded as separating the lowland from the upland.

Upland.—Previous to the development of the present stream valleys and basins the country evidently was a nearly smooth plain. Evidences of this are seen in the nearly even elevation of the higher tables and escarpments, which have a slight eastward slope. The grade of the original plain is the gradual slope from the mountains toward the Mississippi Valley. Considered with respect to its physiographic relations, it is a portion of what is denominated the Great Plains plateau. It was formed in Tertiary time by the deposition of sediments in broad, apron-like sheets spread eastward from the mountains. It has been largely preserved to the present time, and the undissected areas form the High Plains. They constitute the upland of the area here discussed.

Lowland.—Along the Platte Valley, where there are a number of small streams which have a grade dependent upon that of the Platte River and reaching up the larger tributaries for a considerable distance, a lowland has been developed, which is gradually being extended as the escarpments recede and the isolated hills are removed by erosion. Goshen Hole, the name of which is unfortunately suggestive of an inclosed basin, is a portion of this lowland plain which is open eastward to the valleys of the Platte and Horse Creek. Its western rim is the escarpment which has been already referred to as marking the line between the general upland and lowland.

The origin of the Goshen Hole lowland appears to have been due to the fact that the Brule clay, which is found throughout the region, is readily eroded when once the protecting covering of the Arikaree sands is removed. This process is hastened by the issuance of ground water as a seepage flow and as springs at the line of contact between the two formations. At this horizon erosion progresses by sapping, which undermines the cliffs and causes the escarpment to retreat. The western limit of the lowland along the Platte River is practically at the Narrows, a few miles below the point where the Laramie River enters the Platte, on the western border of the Patrick quadrangle. At this place the contact between the Brule and the Arikaree is at

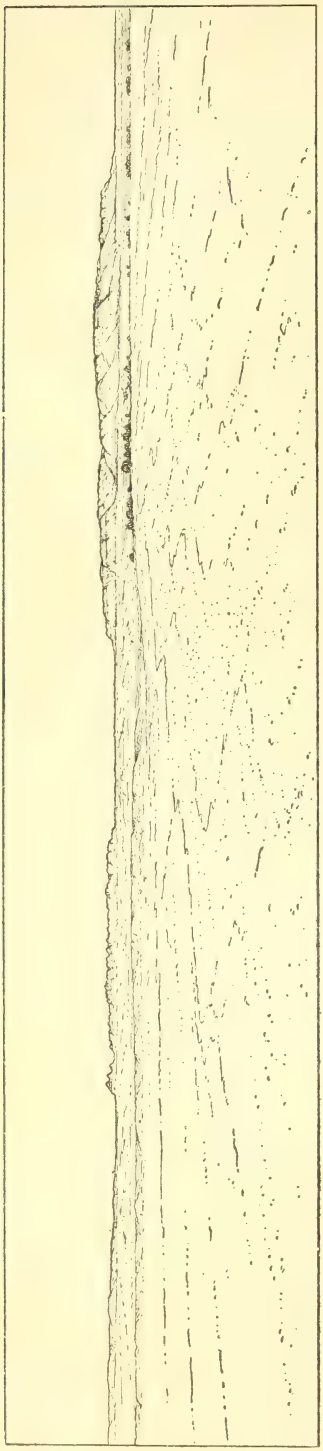


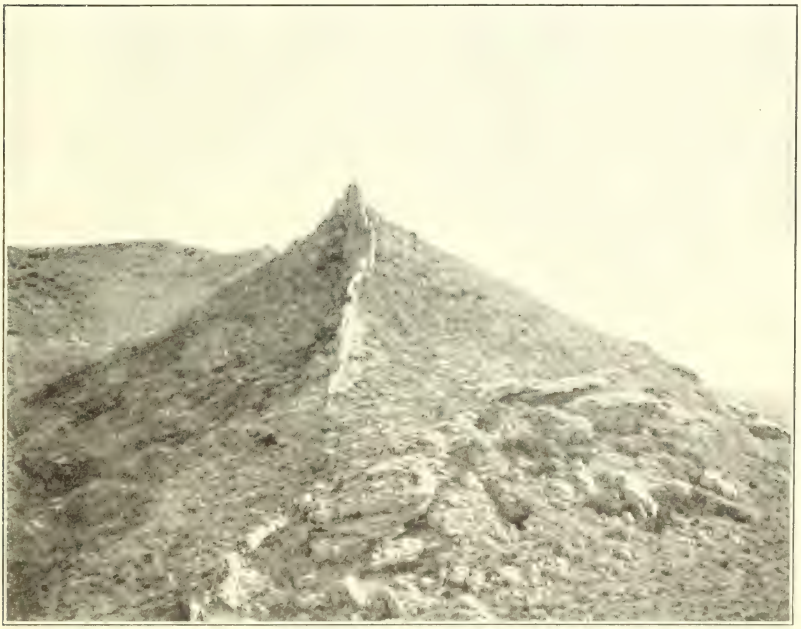
FIG. 3.—Sketch of Bear Creek Mountain and Fox Creek Gap, seen from the southeast.

the level of the river. Along Rawhide Creek the limit of the lowland is similarly at this line of contact north of Snow's ranch. Where the Goshen Hole escarpment is well developed the contact between the two formations occurs in its face, as at the Point of Rocks, east of Snow's ranch and the hills north of Sturdivant's ranch. In Nebraska north of the Platte River the escarpment is not conspicuous except at a few points.

The principal cause of the escarpment being best defined at the western border of Goshen Hole is the fact that practically no streams enter the lowland from that side. Upon examining the general map it will be seen that the drainage which flows eastward from the Laramie Mountains north of Bear Creek is diverted into the Laramie River by Chugwater Creek, which has a northerly course west of Goshen Hole. The Goshen Hole escarpment has accordingly not been broken by streams, but has retreated as the result of the sapping at its base by the headwaters of the minor drainage.

In the southwestern part of the Goshen Hole quadrangle there is a gradually eastward-sloping surface which corresponds to a former grade of the streams, so that the escarpment is not clearly developed along Bear Creek and Horse Creek, but at many places the contact between the formations is beginning to appear in the more recently developed breaks and bluffs. Following the escarpment which borders the lowland eastward along Pumpkin Creek, we find the Ogallala formation occurring at its summit, the contact between the Ogallala and Arikaree falling in the face of the escarpment well toward its upper part. While the presence of the lowland is here also dependent

A. SANDSTONE DIKE CUTTING THE ARIKAREE FORMATION NORTHEAST OF PINE RIDGE.



B. SANDSTONE DIKE CUTTING THE ARIKAREE FORMATION ON DRY RAWHIDE CREEK.

upon the occurrence of the easily eroded Brule clays, the development of the escarpment is to some extent also the result of the character of the Ogallala, which, like the Arikaree, acts as a capping and protecting member to the clays. A short distance east of the junction of Pumpkin Creek with the Platte the Goshen Hole lowland loses its importance and blends with and becomes simply the Platte Valley. In this portion the Arikaree formation is absent, and the Brule and Ogallala are the formations into which the streams have cut their valleys. The channel of the Platte does not lie so much below the contact between the formations as it does in the Goshen Hole country, and this, together with the absence of the Arikaree, probably accounts for the topographic forms being of less pronounced character. The floor of the Goshen Hole lowland is very largely the Brule clay, but at certain points along the Platte and in Goshen Hole proper erosion has exposed the underlying formations, which are the Chadron and the Laramie.

The forms of relief which are conspicuous within the area of the lowland are the so-called mountains and small mesas or table-lands that are left as remnants of the upland which once extended in a narrow tongue between the North Platte River and the former Horse Creek-Pumpkin Creek Valley[a] (see fig. 3). Eagle Rock, 66 Mountain, Eagle Nest, and the very irregular mountains in Scotts Bluff County, Nebraska, of which Scotts Bluff is a part, are what now remains of this tongue. With the extension of the lowlands back from the streams this divide was gradually dissected until the drainage of the southern valley was diverted through the gap between Bear Creek Mountain and 66 Mountain, following the course of what is now Horse Creek. Since the time of this capture, which deprived Pumpkin Creek of the larger portion of the water that it received from the west, its tributaries in the vicinity of 66 Mountain, which received the run-off water, have become relatively more conspicuous than the old channel, which may now be found indistinctly marked in the nearly level country lying to the east of the bend of Horse Creek, at the point where that stream was diverted to the north.

WATER SUPPLY.

Streams.—The streams of the area flow in a generally eastward direction and are all tributary to the North Platte, which has a southeasterly course through the southwestern part of the Patrick quadrangle and the northeast corner of the Goshen Hole quadrangle. The region is one in which the rainfall is limited. With the exception of the larger streams the channels are dry throughout most of the year. The North Platte, having its source in the mountains of Colorado and receiving large tributaries in Wyoming, which are fed by the melting

[a] The North Platte was considered by Darton (Nineteenth Ann. Rept., Pt. IV, p. 729) as having at one time flowed through the valley of Pumpkin Creek. A study of this area lying to the west, which he did not visit, justifies the explanation above given and accordingly accounts for the nature of the Pumpkin Valley, independent of such a hypothesis.

snows, is perennial and of the greatest importance as a source of water supply. The next largest stream is Horse Creek, which enters the southeast corner of the Goshen Hole quadrangle, then flows northward through its middle portion, and thence eastward to the Platte, which it joins a short distance beyond the border of the area in Nebraska. Its principal tributary is Bear Creek, which is of nearly equal importance to the point of its junction with Horse Creek.

These streams head in the foothills of the southern extension of the Laramie Mountains, and have long, narrow drainage basins. They flow throughout the year, although in places, as a result of the diversion of water for irrigation and the disappearance of the remaining small flow in the gravels and sands, their channels are sometimes nearly dry. Some of the shorter streams which are fed by springs and seeps and flow for a short portion of their course during the dry season are Stinking Water, Spring Branch, and Big Lone Tree Creek. Their courses are indistinct, owing to the fact that they soon sink into the surficial sands which fill the lower portions of their channels.

Fox Creek and Little Horse Creek receive their waters from springs, but, having longer courses and draining larger basins, are almost constant in their flow, although supplying but a limited amount of water. In Goshen Hole, as it is usually limited, there are no perennial streams. Cherry Creek, Box Elder Creek, and Corn Creek are represented on the map as intermittent streams. During a season of heavy rains or cloudbursts the run-off water spreads in a broad sheet along the line of their indistinct channels and for some time after stands in long pools. In the dry seasons they contain a limited amount of water in the canyons at their heads, which is supplied by springs. The larger number of ponds, or water holes as they are commonly called, which are found in Goshen Hole act as natural catchment basins into which the run-off water of the higher lands drains and remains throughout most of the year. A careful survey of the country adjacent to them shows that they have a relation to the indistinct drainage system which exists in the low but very irregular relief. The origin of these ponds or basins will be discussed later in this paper. In the Patrick quadrangle Rawhide Creek is a perennial stream in its upper portion, where its valley is confined between relatively regular bluffs. It has a number of small tributaries which are fed by springs and along which water holes and small channels are found. Along the lower portion of Rawhide Creek the country is nearly level and the water sinks into the surficial sands and gravels except during flood times. In the vicinity of Spoon Butte there are springs which form the head of Sheep Creek. Along the upper part of this stream there are some short tributaries which are likewise fed by springs, and there is a limited amount of water present even during the dry seasons. But where Sheep Creek has a broad valley it is dry for long stretches except during heavy rains. The water which is present rises as springs from the underflow along the

channel. The lower portion of its course, in the southeast corner of Patrick quadrangle, is blocked by a range of sand hills, and the water disappears under them in what is known as the sinks of Sheep Creek. Farther on the channel is again distinct and some water stands in it even in the dry season.

From the foregoing account it will be seen that the country is one in which stream water is a limited resource and is of great importance for the purpose of irrigation as well as in supporting the grazing industry.

Springs.—The principal horizon at which springs occur is the contact between the Brule clay and the Arikaree formation. The Arikaree consists largely of sands, through which the water falling on it percolates until it reaches the underlying clay. This clay is fine grained and homogeneous and is practically impervious. As a result, where the contact between the clay and the overlying Arikaree is exposed the ground water finds issuance in case the dip is such as to bring it to that point. There does not appear to be a very large supply of ground water in any of the formations. This is probably due to the fact that the country is in the semiarid region and the rainfall occurs at irregular intervals and often in the nature of cloudbursts, so that it is carried away as run-off water by streams.

Although there are many springs at the contact above mentioned, they are not strong. In many cases the ground water is only sufficient to keep the upper surface of the clay moistened. Along the face of the escarpments the line of issuance is marked by a darker color, resulting from the presence of water in the clay, and where there is vegetation it is more luxuriant. At the heads of the gulches and small canyons the water from the springs, following under the talus of the slopes, usually unites to form a stream for a short distance. These localities are frequented by cattle and have been taken advantage of for home ranches by the stockmen. The supply from such springs is very limited, and the water usually sinks into the sands of the stream bed in a relatively short distance. Examples of this type of spring may be found at the head of Stinking Water Creek, the spring branches south of Gordon's ranch, the spring branch southwest of Meriden post-office, Fox Creek, Big Lone Tree Creek, the State Line Springs on 66 Mountain, and the tributaries of Sheep Creek north of Sturdivant's ranch.

Within the area of the Arikaree formation there are a number of places at which springs occur. These do not appear to issue at any particular horizon, and in many cases are simply the reappearance of the seepage water which follows along the valleys under the sand. Such springs are found on Red Cloud Slough, J. M. Creek, and the head of Sheep Creek north of Spoon Butte.

Hawk Springs, at the west end of 66 Mountain, is perhaps the largest so-called spring in the Goshen Hole country. At this locality the ground is seepy, and the water rises at a number of places. It has

been dammed in so as to form a small pond, and an irrigation ditch has been constructed to carry the flow onto pasture lands. The source of the water can not be definitely determined. From examination of the valley of Horse Creek, farther south, and a study of the wells adjacent to it, it appears that a considerable quantity of ground water passes laterally from the creek into gravels and sands, and it is not improbable that Hawk Springs is the point of issuance of this water, which follows a natural channel now obscured by surficial material.

Ponds.—Within the area of Goshen Hole there are many shallow ponds, in a large number of which water stands nearly all the year. These ponds are commonly spoken of as water holes (see Pl. X, *B*). They are usually shallow, seldom being over 2 or 3 feet in depth. Their bottoms are filled with mud, which is tramped up by the cattle, and when the water evaporates it leaves a mire in which cattle sometimes stick fast.

The water holes occur in moderate depressions which have a relation to the lines of drainage. These depressions, however, are not infrequently 20 feet below the grade of the channel. Careful instrumental surveys are required in some places to determine in what direction water would flow in case of flood, since the relief is very irregular, and no definite drainage system can be made out by studying channels. The origin of the ponds or water holes is a question of considerable interest. They appear to have been produced in the following ways:

In times of flood the water carries a heavy load of sediment. This sediment, together with the débris of the vegetation, finds lodgment in the greasewood and sagebrush along the streams, and causes a slight damming of the channel. In this way the water courses are ponded. After the run-off water has ceased to flow the ponds are frequented by cattle, which tramp the mud and puddle it so that it holds water much better the second time that it is filled. The cattle in going away carry a considerable quantity of the mud on their feet, and by tramping form an irregular rim at the border of the water.

Another cause of the ponding of the channels is due to the fact that when a stream enters at right angles to the channel its sediments form an alluvial fan. In case of heavy rainfall the sand from a slope down which a stream flows with considerable velocity is carried and deposited as a barrier across the channel. Sometimes a trail crossing a stream breaks the sod, so that a quantity of sand sufficient to obstruct the channel is brought down during a heavy rain. Examples of ponding of this kind may be seen in many of the streams, particularly in the area of the Arikaree formation, which consists largely of sand.

Another probable method of ponding is by solution. The water along the stream channels sinks into the ground at certain places and in percolating carries with it materials in solution, so that a depression is formed where this process continues for a long time. Localities at which this would naturally take place are where the under-

lying formations are porous and capable of carrying a large quantity of ground water. The sinks which originate in this way are readily transformed into water holes when silted up with fine clay.

The wind which carries away the sand and loose clay from the margins of the water holes is also an agency in producing depressions. For a considerable distance around the standing water the ground is made bare by the tramping of the cattle, and the grass is either grazed off by the herds or cut down by the prairie dogs, which have their towns near by. The wind carries away all the loosened material, and in the course of time is undoubtedly a conspicuous factor in deepening the depression. Where the surface formation is of a sandy nature and has beneath it a clay, the action of the wind is undoubtedly sufficient to blow out a considerable basin, and when the sand is carried away down to the depth at which the clay occurs the conditions are supplied for a pond, when there is any large amount of rainfall. Within the area of Goshen Hole there is nearly everywhere present a considerable amount of surficial material, which is largely sand. Blowouts, as they are called, which have a depth of 10 to 15 feet, are not unusual. The bottoms of these are usually the clays or undisturbed and original formations, which are relatively impervious to water. It is probable that the alignment of some of the water holes which seems to indicate a former channel may be the result of the direction of the wind, which has produced a number of blowouts at a locality where, for some reason, the sod has been removed and deflation rendered possible.

Perhaps the most common cause of ponding of stream channels within this area is the drifting of sand. The most notable example of it may be seen on Sheep Creek, where the valley is crossed by a high range of sand hills. Above the barrier of sand the water disappears in what is known as the sinks of Sheep Creek. At this place the stream sinks into the sand and appears lower in the valley, where the channel is unobstructed. The sand hills at the sinks of Sheep Creek, however, do not cause a permanent ponding of water, because they are porous and the basin has not become silted up with clay so as to hold the water. The drifting of the sand occurs on a smaller scale at many places in the area of the Goshen Hole. When once the barrier of sand accumulates across a line of drainage it may become sodded over, and where the relief is low the lines of drainage soon become obscured.

Wells.—Inasmuch as the settlements have usually been made near running water or springs, the wells that have been dug have mostly been shallow ones and obtain the ground water which is found along the valleys of the streams. Lately, however, settlers on the upland have dug wells for domestic use, and deep wells have been drilled in order to supply stock water.

In the southeast corner of the Goshen Hole quadrangle, on the high land, the depth to water is practically the distance which must be

drilled in penetrating from the surface to the level of the Brule clay. The wells in this locality are reported to be from 220 to 300 feet in depth. In the northern part of the Patrick quadrangle, in the vicinity of Lone Sand Hill, deep wells have been drilled to obtain water for cattle, and they reach a depth of from 180 to 250 feet. Inasmuch as this locality is a considerable distance from any known outcrop of the Brule clay and the information as to what was passed through in drilling is not very definite, it can not be determined with certainty whether these wells reach the line of contact between the Arikaree and Brule clay. The probability is, however, that this is the case, since the Arikaree is seldom found to contain much water, and the wells are not exhausted when pumped steadily by means of windmills.

In the portion of the area here discussed in which the surficial materials overlying the Brule clay have a considerable thickness, shallow wells have been found where there are local basins of water held by the irregular surface of the clay. Examples of wells of this class may be found east of La Grange, on the relatively level country south of 66 Mountain. They have a depth of from 20 to 75 feet, some of the deeper ones apparently having penetrated a considerable distance into the clay.

Within the area of Goshen Hole where the Cretaceous formations outcrop some deep wells have been drilled with the hope of finding a supply of water for cattle, and other borings have been made in prospecting for coal along Horse Creek. In all these cases an abundance of water has been found, but it is not of good quality. It is commonly spoken of as being "alkali" or salty. This is not an uncommon characteristic of the water in the Cretaceous formations, and indeed of large areas in Wyoming where the rocks are of other ages. The source of the mineral salts which are contained in the water is not easily explained. Inasmuch as the water at nearly all points is equally bad, the supposition is that the salts are diffused throughout the formation and may be an orginal constituent deposited at the time the sediments were formed.

Where irrigation is carried on the percolation of the water renders the ground springy and wells are sunk only a few feet. The water obtained in such cases, however, is not of good quality, inasmuch as it is the seepage from irrigation, and where the land has been irrigated for a number of years it is apt to contain mineral salts as a result of the long-continued evaporation. These salts are usually spoken of as "alkali." They are in reality sodium chloride or common salt, sodium sulphate, calcium sulphate, or gypsum, and magnesium sulphate, together with certain other salts in smaller quantities. They have the property of making the water hard and rendering it undesirable for domestic use.

Artesian wells.—Thus far no artesian wells have been obtained within the Patrick and Goshen Hole quadrangles which are indicative of general artesian conditions. In prospecting for coal along Horse

Creek some of the wells which reach a considerable depth are reported to have flowed a steady stream, but these wells, inasmuch as the water was not soft and fresh, were not thought worth preserving. Near Robb's ranch there is a shallow well, generally reported to be from 20 to 40 feet deep, which flows a small but steady stream. It is not cased up, and the water which rises in it forms a pool a few feet in diameter, from one side of which the flow escapes. The locality is frequented by stock as a watering place. Nothing could be learned concerning the structure of the formations at this place which was at all conclusive. The surficial materials are extensive in this locality, and the Brule clay apparently underlies them. The depth of the well could not be learned with certainty, and no information was available as to what was passed through in digging it. The probability is that the flow comes from a local basin in which the ground water accumulates.

As to the existence of artesian water at considerable depths in this country, it may be well to state that in case it should be found in the Cretaceous it would probably be in character like that which has been described from the wells in Goshen Hole, not suitable for domestic use and only fairly acceptable for stock water. The water which is found in deep wells drilled on the upland often rises for a considerable distance in the wells, but it does not have sufficient head to flow, and when pumped steadily falls lower, so that it is necessary to pump from the bottom of the well in nearly every case where a large supply is needed. The quality of the water found in the Tertiary is usually good, although not always abundant.

IRRIGATION.

The irrigation enterprises in the Patrick and Goshen Hole quadrangles comprise a large number of ditches. Some of them, however, are short. This is particularly true of those which derive their water from the small streams. Along the Platte River the amount of water available for irrigation purposes is more abundant and the canals are wider and have been carried for several miles. The bottom land of this valley includes most of the cultivated tracts and is at present nearly all under ditches. The canals have not been surveyed in detail, and inasmuch as the water rights have not been adjudicated by the State, the flowage and capacity of many of them is not a matter of record. On the accompanying map, Pl. VIII, the areas which are shown as cultivated land under irrigation are those which were noted and mapped by Mr. Ernest F. Burchard, who assisted in the survey of the region. Not all the ditches have been mapped, since some of them are used only for diverting the water onto meadow and pasture lands. The cultivated area under any ditch varies in size from year to year with the condition of the ditch and the enterprise of the farmer. From time to time contests have arisen as to priority of rights, and because of the limited amount of water available certain canals which are well located have been abandoned. In some cases the water from the

streams is utilized by ditches which do not divert it onto lands that can be economically cultivated.

Little Horse Creek ditches.—Little Horse Creek does not have a very large amount of water in it, except at flood times, but its usual flow is appropriated by small ditches, as are also the flows from spring branches in its valley. The ditches which divert it are the Springdale, Herrick, Gordon, Lykens, and Hoyt.

Horse Creek ditches.—The valley of Horse Creek for a considerable distance in the area here discussed is narrow and somewhat canyon-like. Ditches have been constructed along this portion of its course, but practically all of them have been abandoned, although some of the small ones are used for irrigating gardens and limited meadow lands. The first important ditch within the area here discussed is known as the Code ditch. This diverts the water into what evidently was formerly a valley of Horse Creek before its flow was captured by Little Horse Creek. This valley is known as the Big Draw and has a gentle grade, so that the water is economically applied. This ditch is so situated that it could utilize the entire flow of the stream at its head gate except at flood times. By constructing reservoirs a considerable quantity of flood water might be stored.

On Horse Creek, in the vicinity of La Grange post-office, the flow of the stream is considerable at practically all seasons of the year and is utilized by the La Grange ditches. These are located several miles below the Code ditch, and the flow of the stream at this point is considerably increased over that which passes the head gate of the Code ditch. Below the La Grange ditch the T. M. Herrick ditch and some others are so situated as to utilize the water which passes the La Grange. A small ditch has recently been constructed at Little Willows. It irrigates a narrow tract in the immediate valley of the creek. The next point at which the flow is available for irrigation purposes is near the State line. The Lawrence ditch, which has been constructed at this place, is provided with storage reservoirs and irrigates a considerable tract. There is in addition, a short distance below, the Brazil and Marsh ditch, which is connected with the Lawrence, and the Hockster, Foster, and Roberts ditches, which irrigate small tracts.

Bear Creek ditches.—The valley of Bear Creek, where it is contracted within canyon-like walls, has no large ditches. At nearly every ranch some water is diverted onto narrow meadow lands or garden patches, but the amount irrigated in this way is inconsiderable. These ditches are not shown on the map. To the west of Meriden post-office Spring Branch enters Bear Creek. Its flow is utilized by the Dater ditch, which irrigates only a few acres. Below this point Bear Creek ditch diverts the water on the lands in the vicinity of Meriden post-office. The flow of the stream farther on is utilized by the Vanwedel and Goshen ditches.

Fox Creek ditches.—This stream has a very limited flow, but an

R 64 W
R 63 W
R 62 W
R 61 W
R 60 W
R 57 W
R 58 W
T 29 N
T 28 N
T 27 N
T 26 N
T 25 N
T 24 N
T 23 N
J M Ranch
Red Cloud Slough
Muskrat
Coffee Ranch
Hargreaves Ranch
Lone Sand Hill
Sage Creek
Patrick
Rawhide Creek
Spoon Butte
Snow Ranch
Pine Ridge
Studivant's Ranch
Ft Laramie Sta
Laramie
LUCERNE
Snyder's Ranch
Wyncote
P F Ranch
Vaughn
TORRINGTON
Platte
NORTH
UNION PACIFIC CO
Hoke Ranch
Torrington
Sand Sheep Cr
LARAMIE
River
PRATT
BOUNDARY LINE
Sheep
Creek
Pratt
FARMERS
LEERING DR
MITCHELL
CANAL
Bowlder
White Earth Creek

MAP SHOWING CULTIVATED LANDS UNDER IRRIGATION, AND DISTRIBUTION OF TIMBER

BY ERNEST F. BURCHARD

Scale

LEGEND

Irrigated tracts — Pine and cedar — Cottonwood and willow

effort has been made to utilize it by the Fox Creek and Kessler ditches. The amount of water is sufficient for only small tracts. Lands onto which it is diverted are, however, favorably situated.

Rawhide Creek ditches.—Rawhide Creek has too limited a flow during the dry season to justify the construction of large ditches. The Bartlett, Patrick, and Snow ditches utilize the water of this stream. In addition there are small ones which divert the water onto meadow lands.

Platte River ditches.—On the north side of the Platte River the canals which have been constructed from the vicinity of Fort Laramie

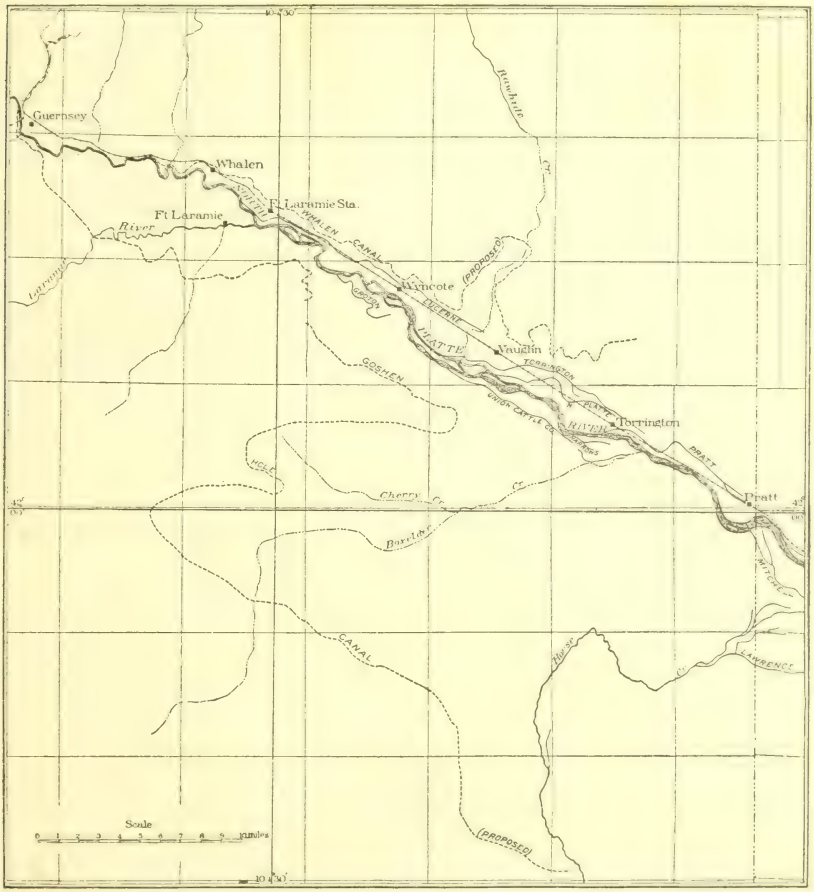


FIG. 4.—Map showing constructed and proposed canals along North Platte River.

eastward are the Lucerne, Torrington, North Platte, and Pratt. The Farmers canal has its head gate at the eastern border of the area. Its flow is utilized principally to the eastward of the area here discussed. On the south side of the river the Grotton, Union Cattle Company, Narrows, and Mitchell ditches are in operation. The last-named one (which irrigates a large tract farther east, in Nebraska) has a second head gate, known as the Gering Branch. The Platte River ditches

are so situated that they are practically above all the alluvium of the valley. This area, however, is not all suitable for cultivation, since some of it is too uneven and other portions are so sandy and gravelly that the water can not be economically applied. With further preparation of the land and by successive saturation of the soil areas which are now not cultivated will be rendered suitable for farm land.

It has been proposed to divert the waters of the North Platte near Guernsey, to the west of the area here discussed, and carry it by means of a long ditch into the Goshen Hole country (see fig. 4). Surveys have been made along the line where this ditch is expected to run, but the cost of construction has been considered relatively too great, and because of having to cross streams and to maintain the canal through a rough country, promoters of this enterprise have been deterred from carrying out their plans. The country in Goshen Hole which this canal is expected to reclaim is, however, of a character suited to irrigation.

Recently surveys have been made for a canal on the north side of the Platte with the head gate at the vicinity of Whalen Canyon (see fig. 4). This ditch is expected to reclaim a large tract of land and has been planned under the provisions of the Carey act.[a] The course which it will follow is relatively long and runs through considerable rough ground, where there will be a loss of water by seepage through the sands and gravel. This loss, however, will diminish as the canal becomes silted up. Besides small tracts along its upper course the area which it is expected to reclaim lies principally along the mouth of Rawhide Creek and east of that stream, which it will cross.

TIMBER, GRASS, AND AGRICULTURAL PRODUCTS.

Timber.—On the High Plains, to which the area here discussed belongs, timber occurs only at favored localities, and seldom in areas sufficiently large to render it a valuable resource. In the absence of coal, wood of any kind is valuable for fuel, and is hauled long distances. The trees which grow on the plains are not very good for building, although they are frequently utilized by the settlers for the construction of log houses and small buildings. Their principal use has been to furnish posts for fences. One reason why the timber does not furnish valuable lumber is because of its slow and stunted growth. Moreover, the varieties do not represent the more durable woods. On the bluffs and escarpments, and occasionally the lone hills, there is a scant growth of pine and cedar. This timber has been largely depleted, and sometimes in cutting it considerable waste has resulted from the leaving of the tops and stumps. After the trees which furnished good logs for building had been cut away and the smaller ones suitable for posts had been used up by the ranchmen, the settlers found that wood was becoming so valuable that they

[a] For the provisions of this act see Appendix.

A. BEAR CREEK MOUNTAIN, LOOKING EASTWARD; ALFALFA FIELD AND MERIDEN POST-OFFICE IN FOREGROUND.

B. EAGLE ROCK AND LONE ROCKS AT FOX CREEK GAP IN ARIKAREE FORMATION.

resorted to the hauling of the stumps and tops for fuel. The area in which the pine and cedar occurs is shown on the accompanying map, Pl. VIII. In nearly all the localities pine trees predominate over the cedar; at no place is there a dense growth. The color symbol indicates the area in which scattered trees are found, and should not be interpreted as denoting well-wooded land.

Along the streams and in the valleys in which small springs occur a growth of deciduous trees is found. The species are relatively few in number, the predominating ones being the cottonwood, willow, and box elder. Their growth is such that they do not furnish good timber, and their principal value, outside of supplying a poor quality of firewood, is in giving shade for cattle in the summer and shelter during winter storms.

The trees which have been able to maintain themselves are those which have abundant and winged seeds. The wind transports the seeds for long distances, and it is probably due to this agency that small clumps of trees are found in gulches at widely separated localities. The occurrence of the trees along the streams where seeds could be transported by water may also be observed on the Platte River, Horse Creek, Rawhide Creek, and the other streams.

The localities which seem favorable to the growth of the soft woods are places in which considerable moisture is present. The pines and cedars, on the contrary, are found on the dry and nearly barren bluffs and escarpments. It is probable that there has never been a broader distribution of timber than at the present time. Except that settlers have cut away the trees, the tendency has been toward an increase rather than a decrease, because of the fact that prairie fires are not allowed to run so widely as in former times.

Grasses.—The surface of the High Plains is largely held by the grass sod. Without this protecting covering the surface would be soon deeply channeled by the run-off water or blown into sand hills. The rock formations and the detritus which results from their weathering are largely sand or material which does not cement readily, and, being in an arid region, is rapidly reduced to small particles and dust which can be transported by the wind. Wherever for any reason the grass has been killed out one can observe the results of wind erosion or the cutting of channels by the run-off water.

The grasses which grow on the High Plains are of many varieties. Probably over 100 species occur within the area here discussed. Their value as forage is known to cattlemen, although the various kinds are not carefully distinguished. The more characteristic types are commonly denominated buffalo grass, grama grass, wheat grass, bunch grass, needle grass, prairie grass, blow-out or sand-hill grass, and nigger-wool or black-root grass. In riding across the prairie the various species may be seen to occur in patches of irregular shape, sometimes of considerable size, but usually they are mingled. Where a single

species occupies an area it may be distinguished from the surrounding grasses by the difference in color and length of stem. Not infrequently several species may be seen growing in distinctly marked patches, all embraced within the range of vision. While the natural grasses of this country, with the exception of a few kinds, are not long enough to furnish hay, they are particularly nutritious and valuable as natural pasturage. To one accustomed to the luxuriant prairie grass of the middle section of the United States the buffalo grass and similar varieties which are sometimes spoken of under the common name of "short grass" appears at first to be valueless as pasturage. As a matter of fact, according to the amount of vegetation, they are richer than the prairie grass. The area required for pasturage is necessarily great because of the small growth. Unlike the prairie grasses, the short grasses cure on the sod and maintain their nutritive value during the winter season, so that they form a natural pasture the year round. When fall rains occur the leaching of the grass lessens its value, but fortunately the seasons are usually dry.

Although the grass of the plains is short, certain species are cut for hay and are found to be of exceptional value. One of these is known as wheat grass. The valuable part of the hay consists of the seed, which somewhat resembles the head of wheat, although much smaller. The longer grasses of the sand hills are also cut, but are not esteemed so highly. In mowing, the hay is made to fall on a table behind the sickle bar, where it is held until a considerable quantity is accumulated, when it is dumped. This obviates the necessity of raking and makes it possible to gather hay which it would be difficult to collect by any other method.

Herbaceous plants.—In the more sandy portion of the country, particularly within the area of Goshen Hole, sagebrush and grease wood are found, practically excluding other plants at certain localities. These herbaceous plants serve the purpose of forage to some extent, but are not so valuable as the prairie grass. Sheep eat them much more than cattle do, and are practically the only stock which can be herded in such an area. Intermingled with the grease wood and sagebrush are large patches of cactus or prickly pear. Where both of these occur the prairie grass is choked out and the land rendered nearly valueless for grazing. The most important function of this class of vegetation is in retaining the sand, which would otherwise be blown into sand hills.

Agricultural products.—Most of the land which is cultivated is under irrigation. The seasons are not favorable for raising grain, although some of it is produced each year. Oats, wheat, and barley do well when irrigated and not attacked by rust or mildew. Inasmuch as the cattle industry requires a large amount of forage, ranchmen have found it to their advantage to raise alfalfa, since its yield is large and it requires little cultivation. The areas indicated on the

A. GOSHEN HOLE ESCARPMENT AND CHIMNEY ROCK; TRELONA POST-OFFICE IN FOREGROUND.

B. WATER HOLE AND CATTLE, GOSHEN HOLE LOWLAND.

map (Pl. VIII) as being irrigated are nearly all devoted to the raising of alfalfa. The hay commands a good price for local use. Along the valleys where it is raised the larger ranches are located, and during winter the cattle which must be fed are brought in off the range and carried through the winter storms by feeding on the alfalfa. The hardier cattle are usually left to graze on land which is reserved for winter pasture. The particular value of alfalfa to the ranchman lies in the fact that he is enabled by feeding it to prevent losses in his herd and bring his stock through in better condition for fattening in the spring, so that they go into the market early.

Forage plants other than alfalfa have not been experimented with extensively. It is not improbable that other crops could be raised which would yield a larger amount of food for cattle per acre than alfalfa. They would require more cultivation, however, and this would be against their popularity in a region where labor is relatively scarce.

In exceptional years good crops can be raised without irrigation, and there are settlers in western Nebraska, adjacent to the area here discussed, who are successful in maintaining farms on the uplands. In Wyoming few attempt to cultivate the prairie land. This difference in the agricultural industry might at first sight appear to be due to a difference in the kind of settlers. In Wyoming the country is given over to ranchmen, who enjoy the privileges of free range, while in Nebraska the herd law protects the settlers, whose crops might otherwise be overrun by cattle even if fairly good fences were built.

SETTLEMENT AND OCCUPANCY OF PUBLIC LANDS.

Early settlement relative to water for stock.—The first settlers in the plains region were cattlemen who located their home ranches with respect to stock water, natural meadow, pasture, and sheltered localities. In the beginning of the stock-raising industry the herds were widely separated and there was no crowding. With increase of the size of the herds and the establishment of ranches by men of large capital, there naturally arose conflicts concerning privileges of the range. In order to maintain themselves and obtain exclusive use of grazing lands, the first effort of the cattlemen was directed to securing the most valuable watering places. Since the streams of the area, with the exception of the larger ones, are not perennial, the first ranches were established on Sheep Creek, Rawhide Creek, Platte River, and Horse Creek and its tributaries. These are to-day the most important ranches, although many others may be found at localities where there is a sufficient supply of water. The lands which were occupied as home ranches were homesteaded, and in each case the land to which title was thus obtained was necessarily a small tract. The ranchman did not need land for agricultural purposes, and with free range his cattle were left to graze as widely as they wished, and

he counted on their return to the watering place as one means of holding his herd together.

After the most desirable locations had been secured for the herds a new ranchman coming into the country found it difficult to obtain open water at a locality where his cattle would have an independent range. The spring branches and smaller streams, and even the ponds, have become important as the crowding of herds has increased. As long as there was no inducement to settlers to homestead the land, because it was of little value for agricultural purposes, the cattlemen by mutual agreement allowed their herds to mingle to a considerable extent, and depended upon the round-ups for keeping track of them. With the passing of the law which provided for obtaining title to the lands by constructing irrigation ditches, a new element entered in the competition for possession of the grazing lands.

Entry of lands under the desert-lands act.[a]—According to the provisions of the so-called desert-lands act, a large number of irrigation ditches were constructed which were intended to utilize the supply of the larger streams. The nature of the country is such that ditches could be built with very little expense, especially if they were made to parallel the stream channels, and inasmuch as there is considerable grade to the streams at some localities, ditches were carried for a considerable distance away from the valleys. Although it was the intention that the ditches constructed under the desert act should be for the purpose of irrigation, in reality many of them simply served the purpose of obtaining title to the land. By constructing a ditch parallel to the stream the use of the water for irrigation purposes was obtained, and also the ownership of the land, which brought with it control of the stream as a watering place for cattle. Since the water supply was not adequate for irrigation purposes all the year round, the cattlemen frequently preferred to allow the water to flow on to a natural meadow or pasture land and make it more valuable for their herds, rather than to attempt the raising of crops. Some of the ditches which were constructed were practically abandoned as soon as the title to the land through which they were built was secured. Where the supply of water in the streams was really adequate for irrigation purposes the ditches which were built are of use at the present time, provided they had prior rights. The ditches, however, which were constructed with second and third rights to the water have in many cases been abandoned because the ditch having the first right takes all the flow at the season of the year when it is most essential to the crops.

As soon as the construction of irrigation ditches began, the cattlemen saw that it would be necessary for them to enter into the projects or they would be deprived of water for their stock. Accordingly, there is hardly any part of the courses of the perennial streams along

[a] For the provisions of this act see Appendix.

which ditches have not been built in order to protect the water rights and obtain titles to the lands bordering the streams. Where there was only a limited supply of water, such as could not be reasonably expected to irrigate a crop, ditches were sometimes constructed in order to obtain title to the land so as to exclude herds from the privilege of watering. Examples of such ditches will be found near springs and along the valleys in which the water flows only at flood time and at other seasons stands in water holes.

The nature of the soil and rock formations in the Patrick and Goshen Hole quadrangles is such that very little work is required in excavating the ditches. On the other hand, the loose and sandy nature of the country rendered a ditch of little value when first constructed, because the water which entered it seeped into the ground. After the flow has been maintained for some time the silting-up process made the ditches carry a larger percentage of the water, but unless they were kept up and utilized for agricultural purposes they soon fell into a poor state of repair, as a result of the breaking down of the banks, which consisted simply of sandy loam. When the water was turned to no other purpose than that of irrigating natural meadows for pasture land, and cattle were allowed to frequent the ditch, it was a matter of but a short time until the herds had destroyed its usefulness.

By reference to the accompanying map, Pl. XI, the reader will see what portion of the country was entered under the desert-lands act. The percentage of land to which title was obtained under the provisions of this act is relatively large as compared with the whole amount of land thus far entered by settlers. A considerable portion of the land entered under the desert-lands act was never proved up according to its provisions, because of certain rulings of the Land Office which required a more complete reclamation than the value of the land would warrant. In some instances the cost of constructing ditches or placing them in complete operation would have been too great, and the land, when considered valuable, was reentered under other acts.

While it was not the intention of many who promoted irrigation enterprises to simply obtain title to the land in order to control the range, this was the final result in many cases. Even where the cost of the construction of the ditches was great and fully equal to the cost of the land through other modes of entry, the final result has been the same and the lands are now used only for grazing purposes. The law under which the proposed irrigation ditches in this region will be constructed is known as the Carey act.[a] It supersedes the desert-lands act and provides for more complete reclamation. With the exception of the waters of the Platte, all the supply available for irrigation purposes was practically appropriated under the desert-lands act, and the Carey act will be operative principally along the valley of Platte River.

---

[a] For the provisions of this act see Appendix.

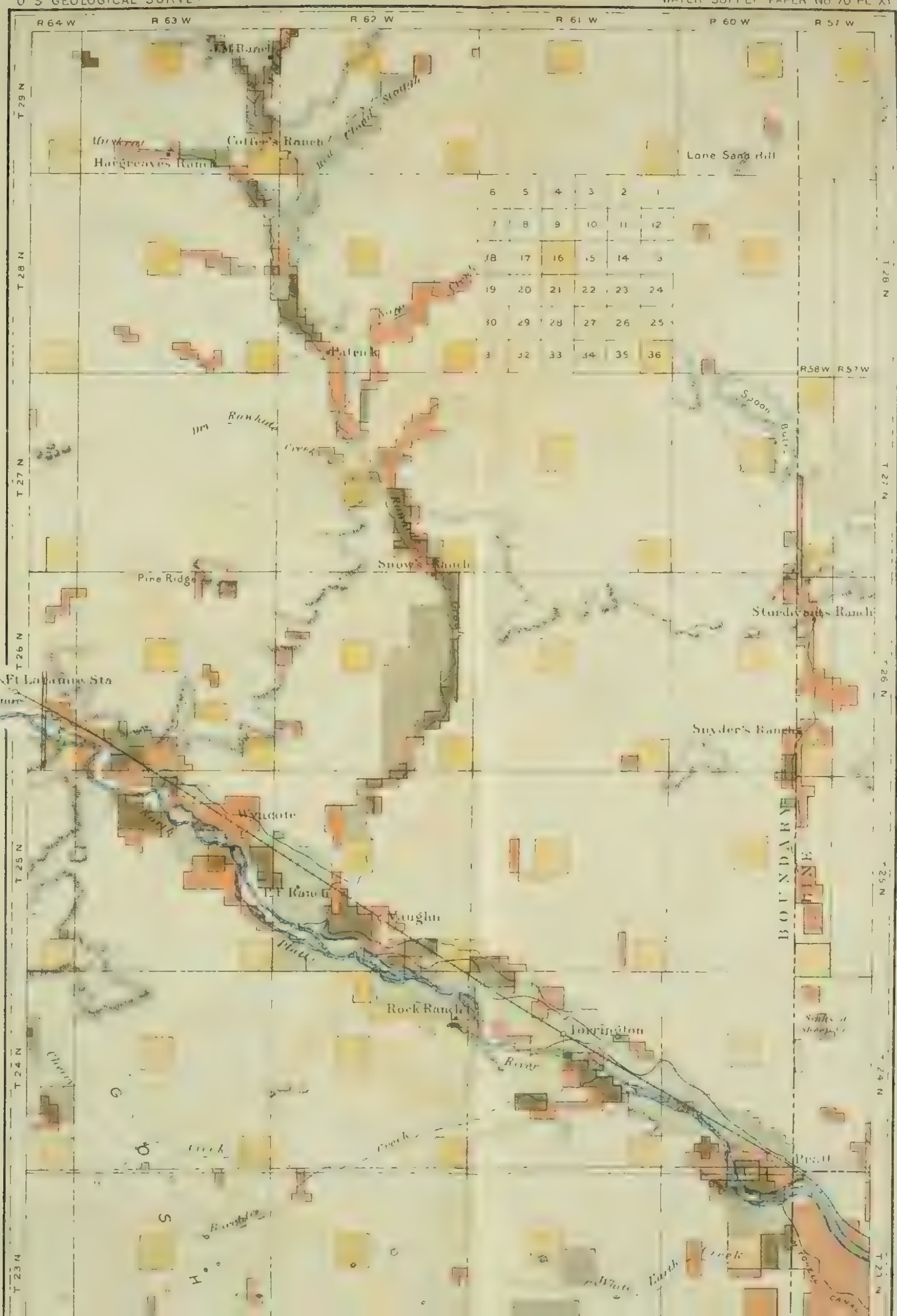
Construction of reservoirs on public lands for watering live stock.—The provisions of the act of Congress relative to the construction on the public domain of reservoirs for watering stock are set forth in the appendix to this paper. The regulations and rulings of the Land Office relative to this act are too lengthy to be set forth here. They provide that not more than 160 acres shall be reserved for a reservoir, and that no reservoir shall be made within a half mile of the boundaries of a group of 160 acres of adjoining or cornering tracts already reserved under this act. Land so reserved shall not be fenced, but shall be kept open to the free use of any person desiring to water animals of any kind. The rulings also provide that the reservoir shall be constructed within two years after the filing for the site.

As a matter of fact, the reservoirs have seldom been constructed. Ranchmen have, however, filed upon such sites as it has been of advantage to them to reserve for free range. Where there has been a probability of a portion of the public domain being included within an illegal fence, the filing of a reservoir site has been resorted to by a rival ranchman in order to protect his interests. Since the lands on which reservoir sites are located are reserved from public sale, filing on them has in some cases been resorted to as a means of preventing the occupancy by prospective settlers under the provisions of other acts.

Entry of lands under the homestead, preemption, timber-culture, timber and stone, and other acts.—Upon examination of the map, Pl. XI, which shows the classes of entry of lands, it will be seen that the portion which lies in Nebraska was practically all taken under the homestead act. During the period when it was supposed that the plains country could be utilized for agricultural purposes settlers were induced to take up the lands of western Nebraska in the more inviting localities, and titles were perfected in a large percentage of cases where the land was entered, although actual residence, cultivation, and improvement were only such as were demanded by the letter of the law. The lands which are owned by private individuals, as a result of this influx of settlers, practically all lies open and unfenced, except where there is a supply of water available for irrigation or for the support of a herd. The ranchmen have acquired simply that portion of the land which borders the streams, and by owning this are able to control the range.

The percentage of land entered under these acts in Wyoming is relatively less than in Nebraska. This is probably due to the different conditions which influenced settlers in going into the plains country, and is largely due to the fact that the law relative to herding and free range was different in the two States.

Occupancy of land not naturally watered.—Recently ranchmen have found that the tracts of land which are not occupied are the broad stretches of upland in which open water is found during only a


R 64 W
R 63 W
R 62 W
R 61 W
R 60 W
R 57 W
R 58 W
T 29 N
T 28 N
T 27 N
T 26 N
T 25 N
T 24 N
T 23 N
Colter's Ranch
Hargreaves Ranch
Lone Sand Hill
Patrick
Dry Rawhide Creek
Spoon Butte
Snow's Ranch
Pine Ridge
Sturdevants Ranch
Ft Laramie Sta
Ft Laramie
Snyder's Ranch
Wyatote
T. T. Ranch
Vaughn
Rock Ranch
Torrington
BOUNDARY LINE
Cherry Creek
Platte River
Torrington Canal

MAP SHOWING CLASSES OF ENTRY OF PUBLIC LANDS AND STATE SELECTIONS

COMPILED FROM LAND OFFICE RECORDS SEPTEMBER 1901

LEGEND

Desert entry title perfected

Desert entry no final proof

Desert entry cancelled

Desert entry under other acts

Entered under the U.S. homestead timber and stone

State

part of the year. In order to utilize this type of country, wells have been drilled and windmills erected. The water obtained by pumping is stored in tanks and allowed to flow into watering troughs, so as to furnish the cattle a constant supply. The percentage of successful wells thus far has been encouraging, and there promises to be a larger number in operation in the near future. There are advantages in such a method of watering stock over the usual method of allowing them to run to ponds or streams, particularly where there is no constant flow. The water supply in watering troughs at the wells can be kept clean, and by having the wells distributed at regular intervals the distance which the cattle have to travel is practically reduced to the distance which they naturally go in grazing.

At the present time the school lands and State selections may be leased for 5 per cent per annum of their appraised value. The minimum for grazing lands is $16 for a section of 640 acres. By leasing these lands the stockmen have locations for wells which they may control, and the intermediate country being a free range, they are practically in possession of all of it for grazing purposes. This method of occupancy does not necessitate the expenditure of any large sum in permanent improvements, and at the same time it enables the ranchmen on the high prairies away from the streams to become strong competitors for the use of the range. Previous to such occupancy the cattlemen who controlled the water of the streams had, by mutual agreement, determined the amount of the range which they would use individually, and in many cases had constructed fences which embraced large tracts of the public domain. As soon as a newcomer establishes himself in the midst of this range by digging a well and constructing watering tanks, he is in a position to demand an equal share with the others. In this way the illegal fencing will soon be done away with, and the owners of the lands adjacent to the streams will no longer monopolize the range.

APPENDIX.

DESERT-LANDS ACT.

AN ACT to provide for the sale of desert lands in certain States and Territories.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That it shall be lawful for any citizen of the United States, or any person of requisite age "who may be entitled to become a citizen, and who has filed his declaration to become such," and upon payment of twenty-five cents per acre, to file a declaration, under oath, with the register and the receiver of the land district in which any desert land is situated, that he intends to reclaim a tract of desert land, not exceeding one section, by conducting water upon the same within the period of three years thereafter: *Provided, however*, That the right to the use of water by the person so conducting the same on or to any tract of desert land of six hundred and forty acres shall depend upon bona fide prior appropriation; and such right shall not exceed the amount of water actually appropriated and necessarily used for the purpose of irrigation and reclamation; and all surplus water over and above such actual appropriation and use, together with the water of all lakes, rivers, and other sources of water supply upon the public lands, and not navigable, shall remain and be held free for the appropriation and use of the public for irrigation, mining, and manufacturing purposes subject to existing rights. Said declaration shall describe particularly said section of land if surveyed, and if unsurveyed shall describe the same as nearly as possible without a survey. At any time within the period of three years after filing said declaration, upon making satisfactory proof to the register and receiver of the reclamation of said tract of land in the manner aforesaid, and upon the payment to the receiver of the additional sum of one dollar per acre for a tract of land not exceeding six hundred and forty acres to any one person, a patent for the same shall be issued to him: *Provided*, That no person shall be permitted to enter more than one tract of land, and not to exceed six hundred and forty acres, which shall be in compact form.

SEC. 2. That all lands exclusive of timber lands and mineral lands which will not, without irrigation, produce some agricultural crop, shall be deemed desert lands within the meaning of this act, which fact shall be ascertained by proof of two or more credible witnesses under oath, whose affidavits shall be filed in the land-office in which said tract of land may be situated.

SEC. 3. That this act shall only apply to and take effect in the States of California, Oregon, and Nevada, and the Territories of Washington, Idaho, Montana, Utah, Wyoming, Arizona, New Mexico, and Dakota, and the determination of what may be considered desert land shall be subject to the decision and regulation of the Commissioner of the General Land Office.

Approved, March 3, 1877. (19 Stat. L., p. 377.)

By the act approved March 3, 1891 (26 Stat. L., 1096), entitled "An act to repeal timber-culture laws, and for other purposes," the following sections were added to the desert-lands acts:

SEC. 4. That at the time of filing the declaration hereinbefore required the party shall also file a map of said land, which shall exhibit a plan showing the mode of contemplated irrigation, and which plan shall be sufficient to thoroughly irrigate and reclaim said land, and prepare it to raise ordinary agricultural crops, and shall also show the source of the water to be used for irrigation and reclamation. Persons entering or proposing to enter separate sections or fractional parts of sections, of desert lands may associate together in the construction of canals and ditches for irrigating and reclaiming all of said tracts, and may file a joint map or maps showing their plan of internal improvements.

SEC. 5. That no land shall be patented to any person under this act unless he or his assignors shall have expended in the necessary irrigation, reclamation, and cultivation thereof, by means of main canals and branch ditches, and in permanent improvements upon the land, and in the purchase of water rights for the irrigation of the same, at least three dollars per acre of whole tract reclaimed and patented in the manner following: Within one year after making entry for such tract of desert land as aforesaid, the party so entering shall expend not less than one dollar per acre for the purposes aforesaid; and he shall in like manner expend the sum of one dollar per acre during the second and also during the third year thereafter, until the full sum of three dollars per acre is so expended. Said party shall file during each year with the register, proof, by the affidavits of two or more credible witnesses, that the full sum of one dollar per acre has been expended in such necessary improvements during such year, and the manner in which expended, and at the expiration of the third year a map or plan showing the character and extent of such improvements. If any party who has made such application shall fail during any year to file the testimony aforesaid, the lands shall revert to the United States, and the twenty-five cents advanced payment shall be forfeited to the United States, and the entry shall be canceled. Nothing herein contained shall prevent a claimant from making his final entry and receiving his patent at an earlier date than hereinbefore prescribed, provided that he then makes the required proof of reclamation to the aggregate extent of three dollars per acre: *Provided*, That proof be further required of the cultivation of one-eighth of the land.

SEC. 6. That this act shall not affect any valid rights heretofore accrued under said act of March third, eighteen hundred and seventy-seven, but all bona fide claims heretofore lawfully initiated may be perfected, upon due compliance with the provisions of said act, in the same manner, upon the same terms and conditions, and subject to the same limitations, forfeitures, and contests as if this act had not been passed; or said claims, at the option of the claimant, may be perfected and patented under the provisions of said act, as amended by this act, so far as applicable; and all acts and parts of acts in conflict with this act are hereby repealed.

SEC. 7. That at any time after filing the declaration, and within the period of four years thereafter, upon making satisfactory proof to the register and the receiver of the reclamation and cultivation of said land to the extent and cost and in the manner aforesaid, and substantially in accordance with the plans herein provided for, and that he or she is a citizen of the United States, and upon payment to the receiver of the additional sum of one dollar per acre for said land, a patent shall issue therefor to the applicant or his assigns; but no person or association of persons shall hold, by assignment or otherwise prior to the issue of patent, more than three hundred and twenty acres of such arid or desert lands;

but this section shall not apply to entries made or initiated prior to the approval of this act: *Provided, however*, That additional proofs may be required at any time within the period prescribed by law, and that the claims or entries made under this or any preceding act shall be subject to contest, as provided by the law relating to homestead cases, for illegal inception, abandonment, or failure to comply with the requirements of law, and upon satisfactory proof thereof shall be canceled, and the lands and moneys paid therefor shall be forfeited to the United States.

SEC. 8. That the provisions of the act to which this is an amendment, and the amendments thereto, shall apply to and be in force in the State of Colorado, as well as the States named in the original act; and no person shall be entitled to make entry of desert land except he be a resident citizen of the State or Territory in which the land sought to be entered is located.

The Commissioner of the General Land Office interpreted this act as follows:

The act of March 3, 1877, entitled "An act to provide for the sale of desert lands in certain States and Territories" (19 Stat. L., 377; Appendix, No. 4, p. 164), contained three sections. By the act of March 3, 1891 (26 Stat. L., 1095; Appendix, No. 44, p. 221), five sections were added thereto, numbered from 4 to 8. The first section provides for the reclamation of such lands by "conducting water upon the same." The second section provides "that all lands, exclusive of timber lands and mineral lands, which will not, without artificial irrigation, produce some agricultural crop shall be deemed desert lands within the meaning of this act," and the third section provides that "this act shall only apply to and take effect in the States of California, Oregon, and Nevada, and the Territories of Washington, Idaho, Montana, Utah, Arizona, New Mexico, Wyoming, and Dakota, and the determination of what may be considered desert land shall be subject to the decision and regulation of the Commissioner of the General Land Office."

It is therefore prescribed as follows:

First. Lands bordering upon streams, lakes, or other natural bodies of water, or through or upon which there is any river, stream, arroyo, lake, pond, body of water, or living spring, are not subject to entry under the desert-land law until the clearest proof of their desert character is furnished.

Second. Lands which produce native grasses sufficient in quantity, if unfed by grazing animals, to make an ordinary crop of hay in usual seasons are not desert lands.

Third. Lands which will produce an agricultural crop of any kind in amount to make the cultivation reasonably remunerative are not desert.

Fourth. Lands containing sufficient moisture to produce a natural growth of trees are not to be classed as desert lands.

CAREY ACT.

Section 4 of the act of August 18, 1894, entitled "An act making appropriations for sundry civil expenses of the Government for the fiscal year ending June 30, 1895, and for other purposes" (28 Stat. L., 372–422), authorizes the Secretary of the Interior, with the approval of the President, to contract and agree to patent to the States of Washington, Oregon, California, Nevada, Idaho, Montana, Wyoming, Colorado, North Dakota, South Dakota, and Utah, or any other States, as provided in the act, in which may be found desert lands, not to exceed 1,000,000 acres of such lands to each State, under certain conditions.

The text of the act is as follows:

SEC. 4. That to aid the public-land States in the reclamation of the desert lands therein, and the settlement, cultivation, and sale thereof in small tracts to actual settlers, the Secretary of the Interior, with the approval of the President, be, and hereby is, authorized and empowered, upon proper application of the State, to contract and agree, from time to time, with each of the States in which there may be situated desert lands as defined by the act entitled "An act to provide for the sale of desert lands in certain States and Territories," approved March third, eighteen hundred and seventy-seven, and the act amendatory thereof, approved March third, eighteen hundred and ninety-one, binding the United States to donate, grant, and patent to the State free of cost for survey or price such desert lands, not exceeding one million acres in each State, as the State may cause to be irrigated, reclaimed, occupied, and not less than twenty acres of each one hundred and sixty-acre tract cultivated by actual settlers, within ten years next after the passage of this act, as thoroughly as is required of citizens who may enter under the said desert-land law.

Before the application of any State is allowed or any contract or agreement is executed or any segregation of any of the land from the public domain is ordered by the Secretary of the Interior, the State shall file a map of the said land proposed to be irrigated which shall exhibit a plan showing the mode of the contemplated irrigation and which plan shall be sufficient to thoroughly irrigate and reclaim said land and prepare it to raise ordinary agricultural crops and shall also show the source of the water to be used for irrigation and reclamation, and the Secretary of the Interior may make necessary regulations for the reservation of the lands applied for by the States to date from the date of the filing of the map and plan of irrigation, but such reservation shall be of no force whatever if such map and plan of irrigation shall not be approved. That any State contracting under this section is hereby authorized to make all necessary contracts to cause the said lands to be reclaimed, and to induce their settlement and cultivation in accordance with and subject to the provisions of this section; but the State shall not be authorized to lease any of said lands or to use or dispose of the same in any way whatever, except to secure their reclamation, cultivation, and settlement.

As fast as any State may furnish satisfactory proof according to such rules and regulations as may be prescribed by the Secretary of the Interior, that any of said lands are irrigated, reclaimed, and occupied by actual settlers, patents shall be issued to the State or its assigns for said lands so reclaimed and settled: *Provided*, That said States shall not sell or dispose of more than one hundred and sixty acres of said lands to any one person, and any surplus of money derived by any State from the sale of said lands in excess of the cost of their reclamation, shall be held as a trust fund for and be applied to the reclamation of other desert lands in such State. That to enable the Secretary of the Interior to examine any of the lands that may be selected under the provisions of this section, there is hereby appropriated out of any moneys in the Treasury, not otherwise appropriated, one thousand dollars.

In the act making appropriations for sundry civil expenses of the Government for the fiscal year ending June 30, 1897, and for other purposes, approved June 11, 1896 (29 Stat. L., 413–434), there is, under the head of appropriation for "Surveying public lands," the following provision:

That under any law heretofore or hereafter enacted by any State, providing for the reclamation of arid lands, in pursuance and acceptance of the terms of the grant made in section four of an act entitled "An act making appropriations

for the sundry civil expenses of the Government for the fiscal year ending June thirtieth, eighteen hundred and ninety-five," approved August eighteenth, eighteen hundred and ninety-four, a lien or liens is hereby authorized to be created by the State to which such lands are granted and by no other authority whatever, and when created shall be valid on and against the separate legal subdivisions of land reclaimed, for the actual cost and necessary expenses of reclamation and reasonable interest thereon from the date of reclamation until disposed of to actual settlers; and when an ample supply of water is actually furnished in a substantial ditch or canal, or by artesian wells or reservoirs, to reclaim a particular tract or tracts of such lands, then patents shall issue for the same to such State without regard to settlement or cultivation: *Provided*, That in no event, in no contingency, and under no circumstances shall the United States be in any manner directly or indirectly liable for any amount of any such lien or liability, in whole or in part.

The limitation of time in the above-quoted section 4 was modified by section 3 of the act entitled "An act making appropriations for sundry civil expenses of the Government for the fiscal year ending June thirtieth, nineteen hundred and two, and for other purposes," approved March 3, 1901 (31 Stat. L., 1133–1188), which provides as follows:

SEC. 3. That section 4 of the act of August eighteenth, eighteen hundred and ninety-four, entitled "An act making appropriations for sundry civil expenses of the Government for the fiscal year ending June thirtieth, eighteen hundred and ninety-five, and for other purposes," is hereby amended so that the ten years' period within which any State shall cause the lands applied for under said act to be irrigated and reclaimed, as provided in said section as amended by the act of June eleventh, eighteen hundred and ninety-six, shall begin to run from the date of approval by the Secretary of the Interior of the State's application for the segregation of such lands; and if the State fails within said ten years to cause the whole or any part of the lands so segregated to be so irrigated and reclaimed, the Secretary of the Interior may, in his discretion, continue said segregation for a period of not exceeding five years, or may, in his discretion, restore such lands to the public domain.

AN ACT PROVIDING FOR THE CONSTRUCTION OF RESERVOIRS ON PUBLIC LANDS FOR WATERING LIVE STOCK.

The act approved January 13, 1897 (29 Stat. L., 484), entitled "An act providing for the location and purchase of public lands for reservoir sites," is as follows:

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That any person, live-stock company, or transportation corporation engaged in breeding, grazing, driving, or transporting live stock may construct reservoirs upon unoccupied public lands of the United States, not mineral or otherwise reserved, for the purpose of furnishing water to such live stock, and shall have control of such reservoir, under regulations prescribed by the Secretary of the Interior, and the lands upon which the same is constructed, not exceeding one hundred and sixty acres, so long as such reservoir is maintained and water kept therein for such purposes: *Provided*, That such reservoir shall not be fenced and shall be open to the free use of any person desiring to water animals of any kind.

SEC. 2. That any person, live-stock company, or corporation desiring to avail themselves of the provisions of this act shall file a declaratory statement in the United States land office in the district where the land is situated, which statement shall describe the land where such reservoir is to be or has been constructed; shall state what business such corporation is engaged in; specify the capacity of the reservoir in gallons, and whether such company, person, or corporation has filed upon other reservoir sites within the same county; and if so, how many.

SEC. 3. That at any time after the completion of such reservoir or reservoirs which, if not completed at the date of the passage of this act shall be constructed and completed within two years after filing such declaratory statement, such person, company, or corporation shall have the same accurately surveyed, as hereinafter provided, and shall file in the United States land office in the district in which such reservoir is located a map or plat showing the location of such reservoir, which map or plat shall be transmitted by the register and receiver of said United States land office to the Secretary of the Interior and approved by him, and thereafter such land shall be reserved from sale by the Secretary of the Interior so long as such reservoir is kept in repair and water kept therein.

SEC. 4. That Congress may at any time amend, alter, or repeal this act.

Although the title indicates that lands are to be sold for reservoir sites, the act does not provide for the sale of any lands, and therefore no lands can be sold under its provisions. The act, however, directs the Secretary of the Interior to reserve the lands from sale after the approval of the map showing the location of the reservoir.

INDEX.

Page.

Agricultural products, kinds of 36–37
Alfalfa, production of 36–37
Alluvium in flood plain of Platte River, character of 20
of, plate showing 22
Arikaree formation, conglomerate near base conglomeratic beds in 17
occurrence and phases of 16–18
sandstone dikes in 18
sandstone dikes cutting, plate showing. 24
springs within area of 27
Artesian water in the quadrangles, existence and probable character of 31
Bear Creek, irrigation from 32
Bear Creek Mountain, plate showing 34
sketch of 24
Big Lone Tree Creek, character of 26
Box Elder Creek, character of 26
Brule formation, occurrence and character of 16
Burchard, E. F., aid by 31
Carey act, provisions of 44
reclamation of lands under 13, 34, 39
text of 45
Chadron formation, occurrence and outcrops of 15–16
Chadron sandstone, plate showing 18
Cherry Creek, character of 26
Chimney Rock, plate showing 36
Coal in valley of Horse Creek, outcrops of .. 15
Conglomerate near base of Arikaree formation, plate showing 22
Conglomerate west of Rawhide Creek, gravel terrace formed by disintegration of, plate showing 22
Conglomerate beds in Arikaree formation, occurrence and former extent of ... 17–18
Corn Creek, character of 26
Cretaceous rocks, exposures of 14–15
Desert-lands act, additions to 43–44
entry of lands under 38–39
interpretation of 44
reference to 12
text of 42
Dunes, occurrence of 22
Eagle Rock at Fox Creek Gap, views of 20, 34
Elevations within the region 22
Formations, geologic, in the region, description of 13–22
Fox Creek, character of 26
irrigation from 32–33
Fox Creek Gap, sketch of 24
General Land Office, interpretation of desert-lands act by Commissioner of ... 44

Page.

Geographic relations of the quadrangles, map showing 12
Geology of the region, features of 13–22
Goshen Hole, escarpment forming western border of 23
plate showing escarpment of 36
sketch showing west end of 22
Goshen Hole lowland, origin and character of 23–25
plate showing 12
water hole and cattle in, plate showing 36
Goshen Hole quadrangle, geology of, map showing 16
Grasses, occurrence and kinds of 35–36
Gravel terrace formed by disintegration of conglomerate, plate showing 22
occurrence of 21–22
Gravels, stream, from outside areas, deposition of 20
of local origin, occurrence of 20–21
Grazing, area per head required for 13
Grazing lands, settlement and occupancy of 38
Hawk Springs, coal outcrops near 15
features of 27–28
Herbaceous plants, occurrence of 36
Homestead act, entry of public lands under 40
Horse Creek, coal outcrops in valley of 15
features of 26
gravels along valleys of, derivation of .. 21
irrigation from 32
Irrigation, ditches constructed for 31–34
extent and character of 12–13
J. M. Creek, springs on, character of 27
Land, cultivated, under irrigation, map showing 32
Lands, arid, reclamation of 45–46
desert, act providing for sale of 42
Lands, grazing, leasing of 41
Lands, public, entries of, map showing classes of 40
entry of, under desert-lands act 38–39
entry of, under homestead, preemption, timber-culture, timber and stone, and other acts 40
reservoirs on, text of act providing for 46–47
reservoirs for watering live stock constructed on 40
settlement and occupancy of 37–41
Laramie formation, plate showing 18
occurrence and outcrops of 14–15

Page.
Little Horse Creek, character of..... 26
irrigation from 32
Live stock, construction of reservoirs for watering..... 40
Location of the quadrangles 11, 12
Lone rocks at Fox Creek Gap, plate showing..... 34
Lowland of the area, origin and character of 23–25
Newell, F. H., letter of transmittal by 9
North Platte River, canals along, map showing..... 33
course and character of 25–26
Ogallala formation, occurrence and features of 18–19
Patrick quadrangle, geology of, map showing..... 16
Platte River (North), alluvium in flood plain of 20
canals along, map showing..... 33
geological map of region along..... 14
irrigation from 33–34
Platte River Valley, irrigation in 31
Point of Rocks, east of Snow's ranch, plate showing 22
Ponds in Goshen Hole, origin and character of 28–29
Preemption act, entry of public lands under 40
Rawhide Creek, features of..... 26
irrigation from..... 33
Red Clough Slough, springs on, character of 27
Reservoirs on public lands, construction of.. 40

Page.
Reservoirs for watering live stock, act providing for, text of..... 46–47
Robb's ranch, well near, features of..... 31
Sand hills, occurrence of 22
Sheep Creek, features of..... 26–27
springs at head of, character of..... 27
Sixty-six Mountain, view of west end of.... 20
Spring Branch, character of..... 26
irrigation from 32
Springs, occurrence and character of..... 27–28
State selections, entries of, map showing classes of 40
Stinking Water Creek, character of 26
Streams of the area, flow of and irrigation from 25–27
Surface features of the region 22–25
Surficial deposits, origin and extent of..... 19–22
Tertiary formations, occurrence, character, and extent of..... 15–19
Timber, occurrence and uses of 34–35
distribution of, map showing 32
Timber and stone act, entry of public lands under 40
Timber-culture act, entry of public lands under 40
Upland of the area, formation of..... 23
Water for stock, settlement relative to..... 37–38
Water holes. *See* Ponds.
Water supply of the quadrangles..... 25–31
Wells in area of Goshen Hole, quality of water from 30
Wells in the area, depth and character of.. 29–30

O

1895.

Sixteenth Annual Report of the United States Geological Survey, 1894–95, Part II, Papers of an economic character, 1895; octavo, 598 pp.

Contains a paper on the public lands and their water supply, by F. H. Newell, illustrated by a large map showing the relative extent and location of the vacant public lands; also a report on the water resources of a portion of the Great Plains, by Robert Hay.

A geological reconnoissance of northwestern Wyoming, by George H. Eldridge, 1894; octavo, 72 pp. Bulletin No. 119 of the United States Geological Survey.

Contains a description of the geologic structure of portions of the Big Horn Range and Big Horn Basin, especially with reference to the coal fields, and remarks upon the water supply and agricultural possibilities.

Report of progress of the division of hydrography for the calendar years 1893 and 1894, by F. H. Newell, 1895; octavo, 126 pp. Bulletin No. 131 of the United States Geological Survey.

Contains results of stream measurements at various points, mainly within the arid region, and records of wells in a number of counties in western Nebraska, western Kansas, and eastern Colorado.

1896.

Seventeenth Annual Report of the United States Geological Survey, 1895–96, Part II, Economic geology and hydrography, 1896; octavo, 864 pp.

Contains papers on "The underground water of the Arkansas Valley in eastern Colorado," by G. K. Gilbert; "The water resources of Illinois," by Frank Leverett, and "Preliminary report on the artesian waters of a portion of the Dakotas," by N. H. Darton.

Artesian-well prospects in the Atlantic Coastal Plain region, by N. H. Darton, 1896; octavo, 232 pp., 19 plates. Bulletin No. 138 of the United States Geological Survey.

Gives a description of the geologic conditions of the coastal region from Long Island, New York, to Georgia, and contains data relating to many of the deep wells.

Report of progress of the division of hydrography for the calendar year 1895, by F. H. Newell, hydrographer in charge, 1896; octavo, 356 pp. Bulletin No. 140 of the United States Geological Survey.

Contains a description of the instruments and methods employed in measuring streams and the results of hydrographic investigations in various parts of the United States.

1897.

Eighteenth Annual Report of the United States Geological Survey, 1896–97, Part IV, Hydography, 1897; octavo, 756 pp.

Contains a "Report of progress of stream measurements for the calendar year 1896," by Arthur P. Davis; "The water resources of Indiana and Ohio," by Frank Leverett; "New developments in well boring and irrigation in eastern South Dakota," by N. H. Darton, and "Reservoirs for irrigation," by J. D. Schuyler.

1899.

Nineteenth Annual Report of the United States Geological Survey, 1897–98, Part IV, Hydrography, 1899; octavo, 814 pp.

Contains a "Report of progress of stream measurements for the calendar year 1897," by F. H. Newell and others; "The rock waters of Ohio," by Edward Orton, and "A preliminary report on the geology and water resources of Nebraska west of the one hundred and third meridian," by N. H. Darton.

Part II of the Nineteenth Annual contains a paper on "Principles and conditions of the movements of ground water," by F. H. King, and one on "Theoretical investigation of the motion of ground waters," by C. S. Slichter.

1900.

Twentieth Annual Report of the United States Geological Survey, 1898–99, Part IV, Hydrography, 1900; octavo, 660 pp.

Contains a "Report of progress of stream measurements for the calendar year 1898," by F. H. Newell, and "Hydrography of Nicaragua," by A. P. Davis.

1901.

Twenty-first Annual Report of the United States Geological Survey, 1899–1900, Part IV, Hydrography, 1901; octavo, 768 pp.

Contains a "Report of progress of stream measurements for the calendar year 1899," by F. H. Newell; "Preliminary description of the geology and water resources of the southern half of the Black Hills and adjoining regions in South Dakota and Wyoming," by N. H. Darton; and "The High Plains and their utilization," by W. D. Johnson.

Correspondence should be addressed to—

The Director,
United States Geological Survey,
Washington, D. C.

WATER-SUPPLY AND IRRIGATION PAPERS.

1. Pumping water for irrigation, by Herbert M. Wilson, 1896.
2. Irrigation near Phoenix. Arizona, by Arthur P. Davis, 1897.
3. Sewage irrigation, by George W. Rafter, 1897.
4. A reconnoissance in southeastern Washington, by Israel C. Russell, 1897.
5. Irrigation practice on the Great Plains, by E. B. Cowgill, 1897.
6. Underground waters of southwestern Kansas, by Erasmus Haworth, 1897.
7. Seepage waters of northern Utah, by Samuel Fortier, 1897.
8. Windmills for irrigation, by E. C. Murphy, 1897.
9. Irrigation near Greeley, Colorado, by David Boyd, 1897.
10. Irrigation in Mesilla Valley, New Mexico, by F. C. Barker, 1898.
11. River heights for 1896, by Arthur P. Davis, 1897.
12. Underground waters of southeastern Nebraska, by N. H. Darton, 1898.
13. Irrigation systems in Texas, by W. F. Hutson, 1898.
14. New tests of pumps and water lifts used in irrigation, by O. P. Hood, 1898.
15, 16. Operations at river stations, 1897, Parts I, II, 1898.
17. Irrigation near Bakersfield, California, by C. E. Grunsky, 1898.
18. Irrigation near Fresno, California, by C. E. Grunsky, 1898.
19. Irrigation near Merced, California, by C. E. Grunsky, 1899.
20. Experiments with windmills, by Thomas O. Perry, 1899.
21. Wells of northern Indiana, by Frank Leverett, 1899.
22. Sewage irrigation, Part II, by George W. Rafter, 1899.
23. Water-right problems of Bighorn Mountains, by Elwood Mead, 1899.
24, 25. Water resources of the State of New York, Parts I, II, by G. W. Rafter, 1899.
26. Wells of southern Indiana (continuation of No. 21), by Frank Leverett, 1899.
27, 28. Operations at river stations, 1898, Parts I, II, 1899.
29. Wells and windmills in Nebraska, by Erwin Hinckley Barbour, 1899.
30. Water resources of the Lower Peninsula of Michigan, by Alfred C. Lane, 1899.
31. Lower Michigan mineral waters, by Alfred C. Lane, 1899.
32. Water resources of Puerto Rico, by H. M. Wilson, 1900.
33. Storage of water on Gila River, Arizona, by J. B. Lippincott, 1900.
34. Geology and water resources of southeastern South Dakota, by J. E. Todd.
35–39. Operations at river stations, 1899, Parts I–V, 1900.
40. The Austin dam, by Thomas U. Taylor, 1900.
41, 42. The windmill: its efficiency and use, Parts I, II, by E. C. Murphy, 1901.
43. Conveyance of water in irrigation canals, etc., by Samuel Fortier, 1901.
44. Profiles of rivers, by Henry Gannett, 1901.
45. Water storage on Cache Creek, California, by Albert E. Chandler, 1901.
46. Reconn. of Kern and Yuba rivers, Cal., by F. H. Olmsted and M. Manson, 1901.
47–52. Operations at river stations, 1900, Parts I–VI, 1901.
53, 54. Geology and water resources Nez Perce Co., Idaho, Pts. I, II, by I. C. Russell.
55. Geology and water resources portion of Yakima Co., Wash., by G. O. Smith.
56. Methods of stream measurement, 1901.
57. Deep borings in United States, Pt. I, by N. H. Darton, 1902.
58. Water storage on Kings River, California, by J. B. Lippincott, 1902.
59, 60. Development and application of water in southern California, Pts. I, II, by J. B. Lippincott, 1902.
61. Deep borings in United States, Pt. II, by N. H. Darton, 1902.
62, 63. Hydrography of Southern Appalachian region, Pts. I, II, by H. A. Pressey, 1902.
64. Accuracy of stream measurements, by E. C. Murphy, 1902.
65, 66. Operations at river stations, 1901, Pts. I, II, 1902.
67. The motions of underground waters, by C. S. Slichter, 1902.
68. Water storage in the Truckee Basin, Cal.-Nev., by L. H. Taylor, 1902.
69. Water powers of the State of Maine, by H. A. Pressey, 1902.
70. Geology and water resources of the Patrick and Goshen Hole quadrangles, Wyoming-Nebraska, by George I. Adams, 1902.

Other papers are in preparation. These pamphlets will be sent to persons who have assisted in their preparation by replies to inquiries or otherwise. Requests made for a certain paper are granted whenever practicable, but it is impossible to comply with general demands, such as to have all of the series sent. Application should be made either to members of Congress or to—

The Director,
United States Geological Survey,
Washington, D. C.

I 19. 13 : 71

Water-Supply and Irrigation Paper No. 71 Series I, Irrigation, 13

DEPARTMENT OF THE INTERIOR

UNITED STATES GEOLOGICAL SURVEY

CHARLES D. WALCOTT, DIRECTOR

J. L. LUDLOW, C. E. M. S.
M. AM. SOC. C. E.
WINSTON, N. C.

IRRIGATION SYSTEMS OF TEXAS

BY

GOVERNMENT PUBLICATIONS
1938
CLEMSON LIBRARY

THOMAS U. TAYLOR

WASHINGTON
GOVERNMENT PRINTING OFFICE
1902

PUBLICATIONS OF UNITED STATES GEOLOGICAL SURVEY.

The publications of the United States Geological Survey consist of (1) Annual Reports; (2 Monographs; (3) Professional Papers; (4) Bulletins; (5) Mineral Resources; (6) Water-Suppl and Irrigation Papers; (7) Topographic Atlas of United States, folios and separate sheet thereof; (8) Geologic Atlas of United States, folios thereof. The classes numbered 2, 7, and are sold at cost of publication; the others are distributed free. A circular giving complete list may be had on application.

The Bulletins, Professional Papers, and Water-Supply Papers treat of a variety of subjects and the total number issued is large. They have therefore been classified into the following series: A, Economic geology; B, Descriptive geology; C, Systematic geology and paleontology D, Petrography and mineralogy; E, Chemistry and physics; F, Geography; G, Miscellaneous H, Forestry; I, Irrigation; J, Water storage; K, Pumping water; L, Quality of water; M, Meth ods of hydrographic investigation; N, Water power; O, Underground waters; P, Hydrographic progress reports. Complete lists of series I to P follow. (WS=Water-Supply Paper; B=Bul letin; PP=Professional Paper.)

Series I—Irrigation.

[See last page of this cover.]

Series J—Water Storage.

WS 33. Storage of water on Gila River, Arizona, by J. B. Lippincott. 1900. 98 pp., 33 pls.
WS 40. The Austin dam, by Thomas U. Taylor. 1900. 51 pp., 16 pls.
WS 45. Water storage on Cache Creek, California, by A. E. Chandler. 1901. 48 pp., 10 pls.
WS 46. Physical characteristics of Kern River, California, by F. H. Olmsted, and Reconnaissance of Yuba River, California, by Marsden Manson. 1901. 57 pp., 8 pls.
WS 58. Storage of water on Kings River, California, by J. B. Lippincott. 1902. 100 pp., 32 pls.
WS 68. Water storage in Truckee Basin, California-Nevada, by L. H. Taylor. 1902. 90 pp., 8 pls.

The following paper also should be noted under this heading: Reservoirs for irrigation, by J. D. Schuyler, in Eighteenth Annual, Part IV.

Series K—Pumping Water.

WS 1. Pumping water for irrigation, by Herbert M. Wilson. 1896. 57 pp., 9 pls.
WS 8. Windmills for irrigation, by E. C. Murphy. 1897. 49 pp., 8 pls.
WS 14. New tests of certain pumps and water lifts used in irrigation, by O. P. Hood. 1898. 91 pp., 1 pl.
WS 20. Experiments with windmills, by T. O. Perry. 1899. 97 pp., 12 pls.
WS 29. Wells and windmills in Nebraska, by E. H. Barbour. 1899. 85 pp., 27 pls.
WS 41. The windmill; its efficiency and economic use, Part I, by E. C. Murphy. 1901. 72 pp., 14 pls.
WS 42. The windmill, Part II (continuation of No. 41). 1901. 73-147 pp., 15-16 pls.

Series L—Quality of Water.

WS 3. Sewage irrigation, by G. W. Rafter. 1897. 100 pp., 4 pls.
WS 22. Sewage irrigation, Part II, by G. W. Rafter. 1899. 100 pp., 7 pls.

Series M—Methods of Hydrographic Investigation.

WS 56. Methods of stream measurement. 1901. 51 pp., 12 pls.
WS 64. Accuracy of stream measurements, by E. C. Murphy. 1902. 99 pp., 4 pls.

Series N—Water Power.

WS 24. Water resources of the State of New York, Part I, by G. W. Rafter. 1899. 92 pp., 13 pls.
WS 25. Water resources of the State of New York, Part II, by G. W. Rafter. 100-200 pp., 12 pls.
WS 44. Profiles of rivers, by Henry Gannett. 1901. 100 pp., 11 pls.
WS 62. Hydrography of the Southern Appalachian Mountain region, Part I, by H. A. Pressey. 1902. 95 pp., 25 pls.
WS 63. Hydrography of the Southern Appalachian Mountain region, Part II, by H. A. Pressey. 1902. 96-190 pp., 26-44 pls.
WS 69. Water powers of the State of Maine, by H. A. Pressey. 1902. 124 pp., 14 pls.

Water-Supply and Irrigation Paper No. 71 Series I, Irrigation, 13

DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY
CHARLES D. WALCOTT, DIRECTOR

IRRIGATION SYSTEMS OF TEXAS

BY

THOMAS U. TAYLOR

WASHINGTON
GOVERNMENT PRINTING OFFICE
1902

J. L. LUDLOW, C. E. M. S.
M. Am. Soc. C. E.
WINSTON, N. C.

CONTENTS.

	Page.
Letter of transmittal	9
Introduction	11
Trans-Pecos systems	13
El Paso Valley	13
Toyah Creek	15
Fort Stockton	17
Santa Lucia	19
Big Bend	19
Pecos Valley systems	21
Margueretta canal	22
Pecos River Irrigation Company	23
Grand Falls	24
Edwards Plateau systems	25
Del Rio	25
Cienagas Creek	27
Mud Creek	27
Las Moras Creek	28
San Saba Valley	30
Upper Nueces	39
Kerr County	42
Kimble and Edwards counties	42
Johnson Fork of Llano River	43
Cedar Creek	45
Bailey Creek	46
Kyac (Cajac) Creek	46
Flemming Branch	47
Little Paint Creek	47
South Llano River	48
Bear Creek	49
Systems at San Antonio and vicinity	51
Mission and neighboring ditches	51
Upper Labor ditch	52
Alamo Madre ditch	52
San Pedro ditch	52
Concepcion ditch	52
San Jose ditch	53
San Juan ditch	53
Espada ditch	53
Truehart ditch	54
Artesian wells	54
Sewage farm	56
Miscellaneous systems	57

Page.
Systems along Lower Nueces River, Lower Rio Grande and Leona River 62
Lower Nueces River 63
Cotulla and vicinity 63
Uvalde 64
Idlewild 64
Carrizo Springs and vicinity 64
Leona River 65
Upper ditch 66
Lower ditch 66
Comanche Irrigation Company's ditch 67
Lower Rio Grande 68
Eagle Pass 68
North Laredo 68
Hidalgo 69
Brownsville and vicinity 69
Colorado Valley systems 70
Sterling County 70
Irion County 71
Tom Green County 71
Brown County 74
Mills County 75
Lampasas County 75
Travis County 75
Systems north of Colorado River 76
Bell County 76
Burnet County 76
Williamson County 76
Milam County 77
Staked Plains 78
Systems north of Texas Pacific Railroad 78
Limestone and Comanche counties 79
Waco and vicinity 80
Rice irrigation systems 82
General features 82
Beaumont section 86
Jefferson County 87
Taylors Bayou 88
Hillebrandt Bayou 92
Pine Island Bayou 94
Neches River 95
Wells 96
Orange County 97
Cow Bayou 97
Adams Bayou 98
Chambers County 98
Turtle Bayou 98
Liberty County 99
Trinity River 99
Wells 99
Harris County 100
Galveston County 102

Rice irrigation systems—Continued. Page.
Brazos Valley section 103
Washington County 103
Austin County 103
San Bernard Creek 103
Fort Bend County 104
Brazoria County 105
Colorado Valley section 107
Colorado County 107
Eagle Lake 107
Colorado River 110
Well plants 111
Wharton County 116
El Campo systems 116
Jackson County 119
Colorado River below Wharton 119
Matagorda County 121
Guadalupe River 123
Dewitt County 123
Victoria County 123
Area devoted to rice culture, by counties 124
Proposed plants 124
Brownsville irrigation system 124
Appendix 125
Index 129

ILLUSTRATIONS

		Page.
PLATE I.	Wing dam of El Paso Irrigation Company	14
II.	*A*, Head gate of Margueretta canal; *B*, Rock cut in curve of West Valley ditch, Margueretta canal	22
III.	Margueretta flume across Pecos River	22
IV.	*A*, Sluice gate used on Margueretta canal; *B*, Measuring weir adopted by Pioneer Canal Company	24
V.	*A*, Dam supplying San Felipe ditch at Del Rio; *B*, Dam supplying Madre ditch at Del Rio	26
VI.	Old stone aqueduct carrying the Espada ditch across Piedras Creek	52
VII.	*A*, Pumping station of Jefferson County Rice Company; *B*, Rice thresher at work on Port Arthur Irrigation Company's plantation	90
VIII.	*A*, Building levees for rice-farm canals, with engine and grading machine, in Matagorda County; *B*, Breaking sod with engines, for rice planting, near Bay City, Matagorda County	120
IX.	*A*, Nile Valley pumping plant; *B*, Baling rice straw for hay, near Bay City	122
FIG. 1.	Map showing irrigation systems in El Paso Valley	14
2.	Map showing Toyah Creek irrigation systems	16
3.	Map showing Fort Stockton irrigation systems	18
4.	Map of Margueretta canal system	22
5.	Map of Grand Falls and Santa Lucia irrigation systems	24
6.	Map of Del Rio irrigation system	26
7.	Map of Cienagas Creek irrigation system	27
8.	Map of Mud Creek irrigation systems	28
9.	Map of Las Moras Creek irrigation systems	29
10.	Map of Menardville irrigation systems	31
11.	Cross section of Sieker's dam on San Saba River	34
12.	Flexible pipe joint used on Mamie ditch	34
13.	Map of Sloan irrigation system	36
14.	Map of Kimble County irrigation systems	43
15.	Cross section of sewer farm ditch at San Antonio	56
16.	Map of Comanche Irrigation Company's ditch near Batesville	67
17.	Map showing location of irrigation ditches in Tom Green County	72
18.	Map showing rice belt of Texas	83
19.	Diagram showing horsepower required for various lifts and acreages	84
20.	Map showing irrigation systems in eastern half of the Beaumont section	86

Page.

FIG. 21. Map showing irrigation systems in western half of the Beaumont section 87
22. Map of Jefferson County Rice Company's farm, showing irrigation canals 90
23. Elevation and section of flume of Beaumont Irrigation Company 94
24. Map showing irrigation canals at Eagle Lake 108
25. Cross section of Eagle Lake Rice Company's siphon under Cane Belt Railroad 109
26. Sand screen for water wells 113
27. Map showing irrigation systems in Colorado Valley below Wharton 120

LETTER OF TRANSMITTAL.

DEPARTMENT OF THE INTERIOR,
UNITED STATES GEOLOGICAL SURVEY,
DIVISION OF HYDROGRAPHY,
Washington, D. C., June 1, 1902.

SIR: I have the honor to transmit herewith a paper entitled Irrigation Systems of Texas, by Thomas U. Taylor, professor of civil engineering at the University of Texas. This paper contains the results of field work carried on by Professor Taylor through several years in connection with the measurement of the principal rivers of Texas and the investigation of the best methods of utilizing the water resources of the State. I recommend it for publication in the series of pamphlets on Water Supply and Irrigation.

A report on the same subject was prepared in 1897 by Mr. William F. Hutson, and printed as Paper No. 13 of this series. Since that time considerable development has taken place in the utilization of water in Texas, and the ground has been gone over with greater thoroughness, resulting in obtaining a larger and more complete presentation of the subject.

In the present report Professor Taylor has discussed the principal irrigation systems in general geographic order, and has given statistics as to the location, cost, and benefits of the devices for obtaining water. He has also devoted some attention to the irrigation of rice, a business in which large amounts of capital are being invested. There has been appended a brief statement of the laws governing irrigation in the State of Texas, also some of the facts obtained from the recent census investigation.

Yours, with respect, F. H. NEWELL,
Hydrographer in Charge.

Hon. CHARLES D. WALCOTT,
Director United States Geological Survey.

IRRIGATION SYSTEMS OF TEXAS.

By Thomas U. Taylor.

INTRODUCTION.

The practice of irrigation in Texas is of considerable antiquity, especially in the western end of the State, along the Rio Grande, where the early Spanish conquerors established settlements, and their descendants, the Mexicans, have maintained possession of the soil for centuries. At San Antonio are ditches whose origin is lost in local tradition, having probably been built to carry water to the grounds surrounding the missions. It is only in comparatively recent years, however, that particular attention has been drawn to the matter, and the importance of the development of the State through irrigation has been appreciated by the public. Already agriculture by means of an artificial supply of water is being practiced in nearly every portion of the State, the greatest increase in acreage being in the rice-growing districts in the southeastern quarter. The figures obtained at the Eleventh Census (1889) and Twelfth Census (1899) illustrate the rapid increase in acreage and the wide extent to which irrigation is now employed.

For most of the land water is obtained by gravity systems of ditches—that is to say, by means of channels through which the water flows from some source at a higher elevation. In many places, however, it is impossible to bring water to the surface of the ground in this way, and it must be lifted or pumped by some mechanical device. For this purpose windmills are most commonly used. West of the one-hundredth meridian north of San Antonio the cattle country of Texas stretches almost unbroken for from 200 to 500 miles. To supply water for the ranches which do not border on or include a flowing stream the windmill has become a most potent factor. In addition, a few localities, like oases, have everlasting springs that rise with surprising suddenness either from the foothills or from the baked prairies. These are in nearly all cases utilized to convert the otherwise unproductive soil into crop-bearing farms. While the old Mexican methods of irrigation are still in use in many localities, with their consequent waste of water, they have been accompanied by few disappointments or heartburnings.

Irrigation in Texas has not escaped the booming influence of the land agent or the subtle promoter. Nearly every county in the western part of the State through which flowing streams course their way has on its maps the sinuous tracings of irrigation systems, while the secretary of state has issued hundreds of charters for systems that fortunately got no further than the charter stage. Some of the promoters, however, with the seductive phrase "modern methods," have formed companies, constructed canals costing hundreds of thousands of dollars, and sold lands, upon flattering prospectuses, to honest and would-be settlers without the slightest data of the available water supply. The collapse of many enterprises and the loss of much money have made the public timid, with the result that two amendments to the State constitution, which carried with them permission to bond certain districts, have been overwhelmingly defeated. The first was prepared in 1897, and under its terms certain districts could, by a majority vote of the landowners, issue bonds for the purpose of constructing irrigation systems. The second amendment, which was voted on in the fall of 1900, carried with it power by virtue of which the people of the Wichita and adjacent districts could issue bonds for the purpose of constructing an immense irrigation system in the Wichita Valley.

With sufficient hydrographic data, however, there was and is no occasion for disappointment; but obtaining these data is a process entirely too slow for the irrigation agent, the promoter, and the developer, and the result is marked by wrecked hopes in many localities. The year 1900, a very wet one, furnished excellent data upon which flattering prospects could be held out to prospective rice farmers, as all streams, bayous, and lakes were full of water and the rainfall was so abundant that only a small amount of artificial watering was required. Result, an excellent crop of rice, a large part of which was watered by Providence. The year 1901, however, was a striking contrast to 1900, for there was no good soaking rain from the time of the Galveston storm, September 8, 1900, until the latest sowing of 1901. The coast country was dry, water was low, and new canals were untried. No two years could emphasize more clearly the need of caution in placing dependence upon a water supply. In the latter year many of the bayous were drawn upon for an amount of fresh water that so lowered their surface level that the salt water of the lower sections backed into them and impregnated the supply. To counteract this, at some places dams have been constructed to check the inflow of sea water.

The irrigation systems of the State have been divided into the following groups: (1) The trans-Pecos systems; (2) the Pecos Valley systems; (3) the Edwards Plateau systems; (4) the systems at San Antonio and vicinity; (5) the systems along Lower Nueces River, Lower Rio Grande, and Leona River; (6) the Colorado Valley sys-

tems; (7) the systems north of Colorado River; and (8) the rice irrigation systems.

The two dry years of 1901 and 1902 have called attention to the necessity of irrigation in what has been heretofore called middle Texas. Farmers are realizing the efficiency of an irrigation system to be put into operation when the rainfall is not sufficient for agricultural purposes. Slowly irrigation for ordinary crops takes its way eastward in Texas. It is now on the Brazos, and another dry season will take it to the Trinity River.

In the preparation of this paper valuable assistance has been rendered by Lester G. Bugbee, instructor in history in the University of Texas; Willard H. Denis, observer at Pecos; Judge O. W. Williams, of Fort Stockton; the late S. C. Dobbins, civil engineer, and T. L. Smith, civil engineer, of Columbia. The writer has also frequently consulted Water-Supply Paper No. 13, prepared by W. F. Hutson.

TRANS-PECOS SYSTEMS.

The portion of the State west of Pecos River is commonly known as trans-Pecos Texas. It is a peculiar country, rough and mountainous, with few perennial streams. The storm waters rush out upon the lowlands and are rapidly absorbed in the sandy plains, from which the mountains rise abruptly as isolated peaks or ranges. The soil of the plains is of remarkable fertility, and when watered produces abundantly. Irrigation away from the creeks, however, is practicable only by means of storage reservoirs holding the storm waters. Reservoir sites occur in many places, and several of them have been mapped by the topographers of the Geological Survey. Trans-Pecos Texas is bounded on the west and south by the Rio Grande, from which water is at present taken for irrigation mainly in the vicinity of the Big Bend. The following irrigation systems occur in the trans-Pecos region: (1) The El Paso Valley systems; (2) the Toyah Creek systems; (3) the Fort Stockton systems; (4) the Santa Lucia systems; and (5) the Big Bend systems.

EL PASO VALLEY.

Franklin canal.—At El Paso the principal canal is that owned by the Franklin Irrigation Company. It was begun in 1889 and completed in 1891. Later the affairs of the company were placed in the hands of a receiver, and the property was bought at a receiver's sale by Thomas Worthington, of Manchester, England, the trustee for the bondholders. The canal begins 1 mile northwest of El Paso, and runs in a general southeasterly direction for 29 miles. (See fig. 1.) At the beginning its width is 30 feet, but it gradually diminishes to 15 feet at Fabens, where it returns to the Rio Grande. Water is diverted by a masonry wing dam extending diagonally up the river about 300

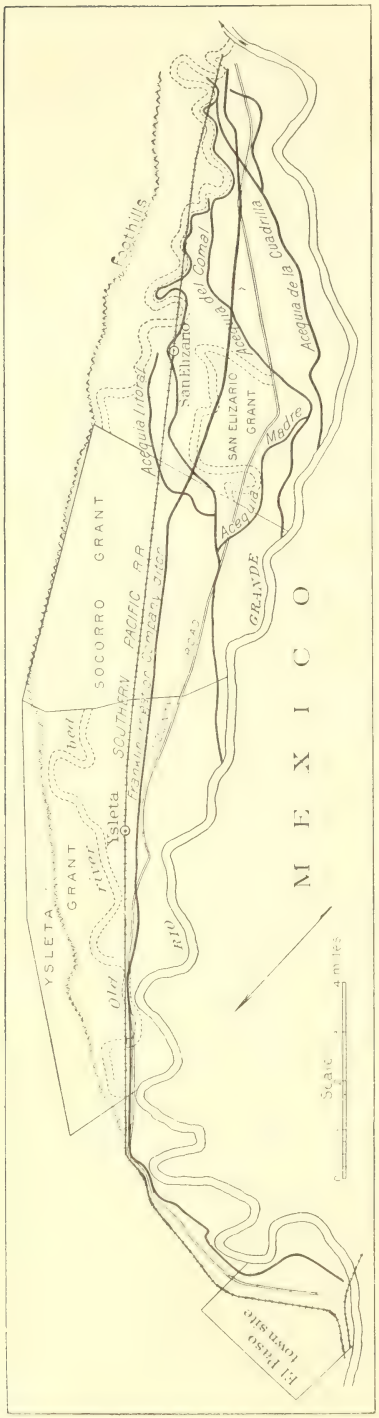


FIG. 1. Map showing irrigation systems in El Paso Valley.

feet and about halfway across, as shown in Pl. I. The original cost was approximately $150,000, and about $70,000 has since been expended for protection from overflows and for repairs. The water rights under the new management have not yet been issued. The yearly water rental was $2 an acre. The canal was designed to cover 30,000 acres. During 1896, 3,000 acres were irrigated from it, but since that time practically no land has been served from this ditch, on account of lack of water in the Rio Grande.

Ysleta, Socorro, and San Elizario ditches.—There are three old Mexican ditches taken from the Rio Grande below El Paso, on the American side, on grants of land made to the inhabitants of Ysleta, Socorro, and San Elizario, capable of irrigating from 1,000 to 1,200 acres each. (See fig. 1.) The ditch on the Ysleta grant was taken out of the Rio Grande about 3 miles south of the present station of Ysleta (not the old town of Ysleta), and continued through the Socorro and San Elizario grants, following the banks of the old river bed after passing the present station of San Elizario. The total length of the main acequia was about 10 miles, and the two branches, the Acequia Littoral and the Acequia Madre, were 4 and 3 miles long, respectively. The Acequia del Comal took its water from the Rio Grande about 15 miles below El Paso, on the lower part of the Socorro grant. It followed the general course of the river for 2½ miles, then ran almost due east for 3½ miles, and finally

WING DAM OF EL PASO IRRIGATION COMPANY.

deflected to follow the banks of the old river bed. Its total length was about 10 miles. The Acequia de la Cuadrilla took its water from the Rio Grande 2 miles below the intake of the Acequia del Comal. Its total length was about 9 miles.

These Mexican ditches are capable of irrigating about 3,000 acres, but the flow of the Rio Grande at El Paso has been so unreliable for several years that it was impossible to base any calculations upon it. A reliable storage reservoir in the mountains above El Paso would serve during its life to make the whole El Paso Valley on both sides of the river for 30 miles one of the most productive countries in the world, for it possesses an unrivaled climate and is capable of producing fruits with a flavor that easily commands for them the highest price wherever they go. The total area on the American side that could be brought into active production would be not less than 40 square miles.

Irrigation has been practiced here probably longer than in any other part of the United States. The old Spanish records show that when this pass was first reached by the exploring party of Coronado, villages of Indians were found on the Mexican side, on the site of the present town of Jaurez, and on the American side at Ysleta and below. These Indians had a system of irrigation of seeming great antiquity, which has been followed by the descendants of the aborigines and their conquerors for three hundred and fifty years.

During the spring of 1897 the large canal was damaged by the flood that submerged so large a portion of the town of El Paso. This flood reached its greatest height on May 26, and quickly subsided. The banks were badly cut, and in some places the canal was completely obliterated. The truck gardens and orchards near the city were flooded and damaged, a layer of mud about 3 inches thick being deposited over the surface. It was noticeable that while most trees withstood the flooding comparatively well, the peach trees were almost uniformly killed. Fortunately for the farmers lower down, a portion of the river cut for itself a new channel, curving inward, crossing the canal, and then recrossing it at the last point at which the banks were damaged. In this way they have been supplied with water and are able to save their crops, which otherwise would be ruined.

TOYAH CREEK.

Toyah Creek rises in natural springs about 40 miles southwest of Pecos. These springs are mainly in section 256, patented by the State of Texas to Antonio Ball. They are in a flat valley, hemmed in by a horseshoe curve of the Davis Mountains. About 3 miles northwest is Phantom Lake. It is stated by close observers that the waters of the creek and lake are of the same composition and general character, and it is probable that the latter is on the underground stream that issues from the earth in the Toyah Springs.

The largest of the Toyah Springs is oval shaped, and is about 100 feet long by 60 feet broad. Its water level in the spring varies with the condition of the weeds and long grass, and also with the weather. The discharge as measured by the writer on September 5, 1900, was 46 second-feet. A large percentage of the water is deflected

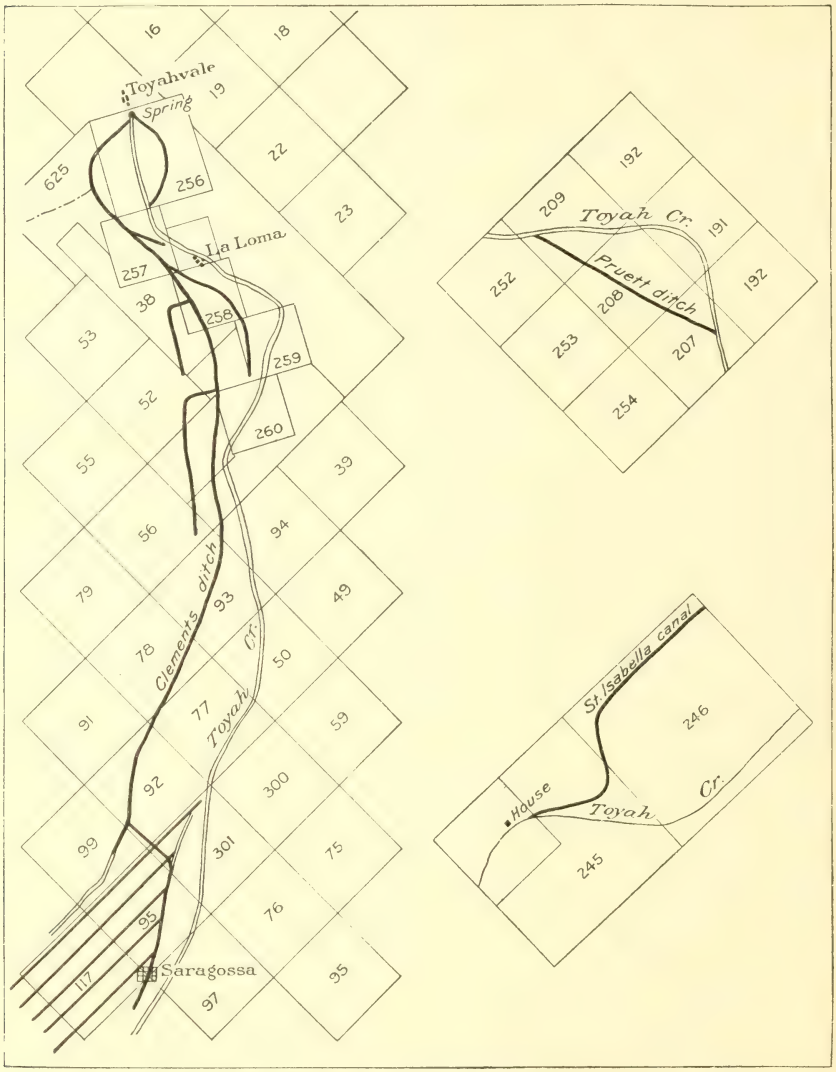


FIG. 2. Map showing Toyah Creek irrigation systems.

into the ditch of Toyah Creek Irrigation Company. The flow of the spring is equal to about 8 heads, a head being defined as the amount of water that flows through an opening 1 foot square, the upper edge of the opening being 4 inches below the water surface. There is an unverified and hazy tradition that the flow once amounted to 12 heads, but this is seriously doubted.

For several miles the creek skirts the foothills of the Davis Mountains, and in addition to the well-known springs mentioned is fed by small invisible springs and by seepage. It empties into Toyah Lake, a large alkali flat depression about 35 miles from Toyahvale and about 12 miles south of Pecos.

In all there are five ditches taken out of Toyah Creek: (1) The Clements or Murphy, 9 miles long, taken out of Toyah Spring, on the south side, and irrigating about 1,500 acres; (2) the Giffin, 1 mile long, taken out of Toyah Creek, on the north side, and irrigating about 400 acres; (3) the Saragossa, 2 miles long, taken out on the south side of the creek, about 6 miles below Toyah Spring, and irrigating 1,500 acres (this is included in the Clements system); (4) the St. Isabella ditch, which irrigates about 700 acres and is 2 miles long, being taken out on the north side of the creek, 19 miles below Toyah Spring; and (5) the Pruett ditch, 2 miles long, headgate 26 miles below Toyah Spring, on the south side, which irrigates about 300 acres. The location of the ditches is shown in fig. 2. The crops raised are mostly corn, wheat, Kafir corn, and sweet potatoes. From Toyahvale to Saragossa the irrigation has been very efficient. A half mile above Saragossa, on the main Saragossa ditch, is Clements's grain and flour mill, an adobe and timber structure, at which there is a fall of 12 feet.

The main irrigation ditch leading from the largest of the Toyah springs (now known as the Clements or Murphy ditch) was projected as early as 1875, but the ditches of the Saragossa and the Toyah Creek companies were chartered in 1875 and 1876. Afterwards the companies passed through various ownerships and changes until 1894, when Mr. E. Clements obtained all the rights and ownership of the Saragossa Company ditch, and in 1895 he obtained a controlling interest in the Toyah Creek ditch. The Saragossa ditch was taken out of Toyah Creek about 6¼ miles below the Toyah Springs and about 1¾ miles above the town of Saragossa. Both ditches are now operated under the Clements management, a lateral connecting them. The original Saragossa ditch was taken out probably as early as 1869, at a point where the bed of the creek ended in rather swampy lands. These lands are now in the Saragossa farm. From the best evidence obtainable the flow of the Saragossa Spring was about 15 second-feet, and it was the largest affluent of Toyah Creek below section 256.

Toyahvale is about an eighth of a mile west of the Toyah Springs; La Loma is about 1 mile below the head spring, on the right bank; India (known as Brogado P. O.) is about 4 miles below the Toyah Springs, on the right bank; while Saragossa is 9 miles below the head spring, on the right bank of the creek.

FORT STOCKTON.

Comanche Creek rises near Fort Stockton, in a clear and bold spring. In 1899 its flow, as determined by measurement, was 70 second-feet. The waters of the creek were first used for irrigation

in 1868, when Cæsario Torres irrigated land belonging to Gen. John Hatch and others. In 1870 the United States Government irrigated about 100 acres, most of which was used for a garden for the post.

In fig. 3 are shown four irrigation ditches taken out of the creek, two on the right or east side and two on the left or west side.

Garza ditch and Comanche Creek Irrigation Company ditch.—The ditches on the right side of Comanche Creek are known as the Garza ditch and the Comanche Creek Irrigation Company's ditch, both of which are owned by the Southwestern Irrigation Company. The former is taken out about 3 miles and the latter 3¼ miles below

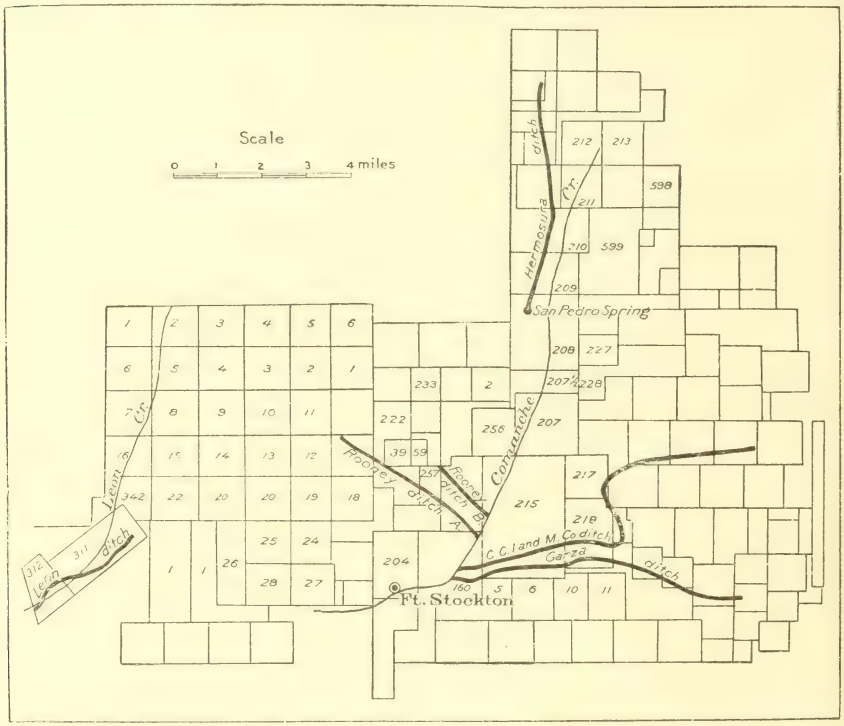


Fig. 3.—Map showing Fort Stockton irrigation systems.

Fort Stockton. A loose dam, made of cottonwood logs and turf, raises the water into the Garza ditch, which is 6 miles long and is used to convey water to cattle ranches. From 600 to 800 acres are irrigated from the lowest (Comanche Creek Irrigation Company) ditch, 400 acres being in alfalfa.

Rooney ditches.—Two ditches, known as the Rooney ditches, and marked A and B in fig. 3, are taken out on the left side of the creek. They were constructed in 1876 and 1877. Ditch A is about 4 miles long, and is taken out about a half mile below the head of the Garza ditch. The Rooney ditches can irrigate 6,000 acres. In 1900 they actually irrigated 1,360 acres, 900 acres being in corn, 400 acres in

cotton, and 60 acres in alfalfa. On ditch A is located the mill belonging to Rooney & Butts, of Fort Stockton. The fall at the gin is 12 feet, and 12 horsepower is developed by a 24-inch Leffel turbine.

Hermosura ditch.—The Hermosura ditch, owned by J. H. Crawford, is 7 miles east of Fort Stockton and receives its waters from the San Pedro Spring, which is in section 208 of the Texas land office map. The flow of the spring is about 4 second-feet, and from it Mr. Crawford irrigates 160 acres of land.

Seven miles west of Fort Stockton Mrs. Royall irrigates 260 acres from the Leon Spring.

SANTA LUCIA.

The Santa Rosa Spring is in section 68 of the Texas land office map. It comes out in a bold stream of about 10 second-feet volume, and flows in the ditch constructed for its control. It is 4½ miles north of the post-office at Santa Lucia, the office being located at the home of Thomas L. Ray, the largest user of the Santa Rosa water for irrigation purposes. The water is under the control of the Pecos River Company, and each irrigator pays 50 cents per year per acre for sufficient for his crops. Mr. Ray planted cottonwoods along the ditches, and now his farm is bordered on the north and west sides by stately trees that can be seen for 20 miles. He lives in section 104, and irrigates 100 acres. Mr. Levi A. Scott lives 2 miles north of Santa Lucia, and irrigates 60 acres from the Santa Rosa (spring) ditch. The crop raised is mostly alfalfa, and when visited in June, 1900, all kinds of stock were being fattened upon green alfalfa. In addition to the alfalfa, Mr. Ray has a thriving orchard of peach trees just coming into thrifty bearing. The Santa Lucia systems are shown in the map, fig. 5.

BIG BEND.

The land along the Rio Grande in the Big Bend is very rich and will raise any crop that grows in Texas. Its yield is enormous, as many as 80 bushels of corn and 50 bushels of wheat being grown to the acre. Irrigation on a small scale is practiced extensively.

Candelaria ditch.—At Candelaria, a Mexican settlement on the Rio Grande about 45 miles from Shafter, there is an irrigation ditch 4 miles long, which was built by the Mexicans. It is fed by Coyote Creek, and irrigates about 200 acres. The Rio Grande is generally dry at this point during the irrigation season, but when it flows part of its waters are deflected into the Candelaria ditch.

Dawson system.—At Shafter Mr. G. S. Dawson has two tanks that are filled from a strong spring. Small ditches, or acequias, lead from the tanks and irrigate his farm, orchard, and garden. The land not in orchard or garden is sowed in wheat, which is cut green to serve for feed, and the land is then plowed and planted in corn and beans.

Del Rosa ditch.—The Rio Rosa ditch is 6 miles long, 6 feet wide,

and from 2 to 4 feet deep. It was built about 1880. A low dam of loose rock, 1 or 2 feet high, is constructed across the Rio Grande, and serves to irrigate about every other year 1,200 acres.

Palvo Irrigation Company ditch.—About 10 miles below Presidio the Palvo Irrigation Company has a ditch 5 miles long, 6 feet wide, and 6 feet deep. Water is obtained by means of a dam of loose rock, 500 feet long and from 2 to 4 feet high, which was constructed across the Rio Grande in 1877. Two miles above Presidio the Rio Concho of Mexico enters the Rio Grande, affording an abundant supply for this ditch. Above the mouth of the Rio Concho the flow of the Rio Grande is unreliable.

Mulato canal.—Opposite the Palvo canal, on the Mexican side, is the Mulato canal, in the State of Chihuahua. This canal shows what can be done by irrigation in the Big Bend. It is 6 miles long, 10 feet wide, 4 feet deep, and supports 1,000 persons. It is taken out of the Rio Grande a short distance below the Palvo dam, and reenters the river at the Mexican village of Mulato, below Palvo.

Ernst and Lindsey systems.—Near Boquillas, on the Rio Grande, in Brewster County, there are two small irrigation plants which take their water from Tornillo Creek, which is dry most of the year, but affords excellent opportunities for impounding. Mr. A. Ernst owns a ditch 900 feet long, 4 feet wide, and 3 feet deep, which was constructed in the early part of 1901, on the east side of the creek. The soil here is sandy and of good productive possibilities. Twenty acres, in corn, cotton, and beans, were irrigated this year (1902). The plant of D. E. Lindsey is on the west side of the creek. The ditch was constructed in 1898. It is 1,500 feet long, 3 feet wide, and 2 feet deep. The earth dam across the creek is 400 feet long and 6 feet high. Thirty acres, in beans and corn, are cultivated at this plant.

Ditches along Alamo and Leoncito creeks.—Two ditches have been taken out of Alamo Creek, in Brewster County. The first of these, taken out in 1880, is 2 miles long, 3 feet wide, and irrigates 250 acres of corn, beans, wheat, and sorghum. The water is deflected into the ditch by a dirt dam 40 feet long and 4 feet high. A ditch has also been taken from Leoncito Creek. Its length is one-fourth of a mile, its width 1 foot. It irrigates 3 acres of alfalfa. Two other small ditches, irrigating about 3 acres each, derive their water from small springs.

Pool system.—A few miles from Shafter, on the ranch of J. R. Pool, 5 acres, in vegetables and fruits, are irrigated. The water is derived from springs, and the peaches produced are of excellent quality and abundant quantity.

Hosier Brothers system.—The Hosier Brothers, near Dryden, have two small ditches, from which 24 acres are irrigated. The larger one is three-fourths of a mile long. It was built in 1898 and 1899, takes its water from a spring, and irrigates 19 acres in corn. The smaller

ditch was built in 1894, is one-fourth of a mile long, takes its water from Arocha Spring Creek, and irrigates 5 acres of sweet potatoes, melons, and vegetables.

Ditches in Jeff Davis County.—In Jeff Davis County, along Limbia Creek, several small gardens and farms, aggregating nearly 100 acres, are irrigated.

Templeton system.—Thirteen miles northwest of Alpine and 15 miles southeast of Fort Davis, in the county of Jeff Davis, there is an irrigated system on the Templeton ranch. Two natural springs from the side of a mountain supply the water to irrigate an 18-acre orchard containing about 2,000 fruit trees, consisting of apples, peaches, plums, pears, apricots, quince, and almond. The two springs irrigate separate pieces of ground. The one near the residence supplies water for domestic use, irrigates about 2 acres, and waters the domestic stock. In connection with this is a cement tank, having a capacity of 11,000 gallons, which is supplied by pipes that lead from the spring and fill it in about thirty-six hours. This amounts to about one-third the flow of the spring. The larger spring irrigates directly 15 acres without the intervention of a reservoir.

Two miles above this place is located a field of about 30 acres which is supplied by one or more springs. No ditches are used, but the forage crops, consisting of alfalfa, Johnson grass, and cane, are subirrigated, and when not used for pasture the field produces three or four crops each year.

PECOS VALLEY SYSTEMS.

Pecos River rises in the northeastern part of New Mexico and flows in a general southerly direction through the southeastern part of that Territory, crossing the western prolongation of Texas and finally entering the Rio Grande at about the lower third of the length of that stream. It is supplied to a considerable extent by water from large springs in the limestone rocks of the region, of which Roswell is now the principal town. These maintain the perennial flow of the river, the run-off from the catchment basin being irregular in character and diminishing at times to relatively small amounts.

Large irrigation works have been constructed in the vicinity of Roswell, which utilize the greater part of the summer flow of the river so that during the dry season of the year little water crosses the Texas line. Large storage reservoirs have been created both at Roswell and above Carlsbad. Between Carlsbad and the Texas State line there are several reenforcing springs. The water that flows in the stream is largely derived from the seepage of irrigated lands above, and is often heavily charged with alkaline salts. Irrigation canals have, however, been constructed along the valley in Texas, principally near the town of Pecos, at the crossing of the Texas and Pacific Railroad. The valley is fertile, and where properly irrigated large crops are produced.

MARGUERETTA CANAL.

The most important irrigation system along the river in Texas is the one about 50 miles from the New Mexico line known as the Margueretta canal system (see fig. 4). It was begun in 1887 by the Pioneer Canal Company, which afterwards consolidated with the Margueretta Canal Company, which now owns the whole system. Water is diverted by means of a brush dam, it being deemed impracticable to build a masonry structure in the sandy river bed. The dam is 250 feet long and 5 feet high. The head gate is shown in Pl. II, *A*. As shown in fig. 4, the canal is taken out of the west side of the river, runs in a southwesterly direction for a distance of 3 miles, crosses the river in a flume (shown in Pl. III), and then runs in a general easterly

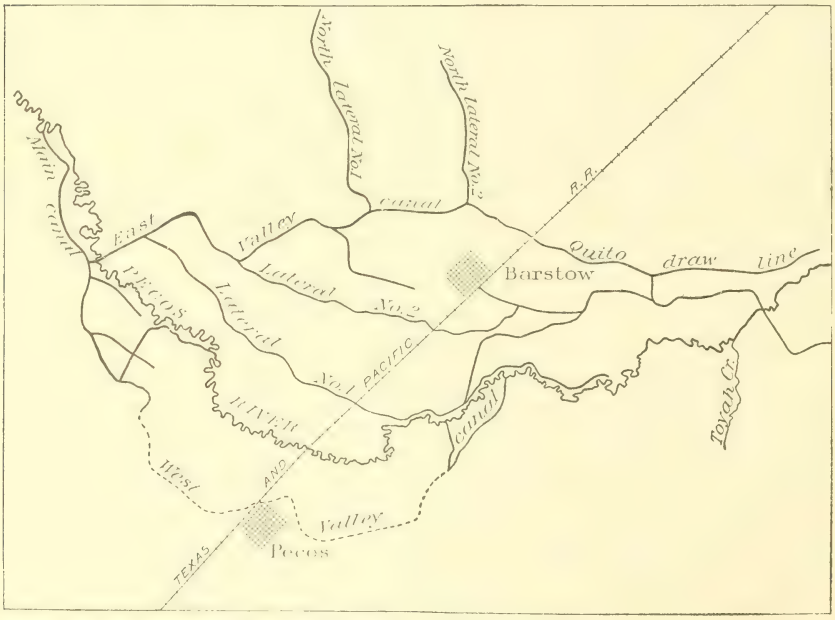
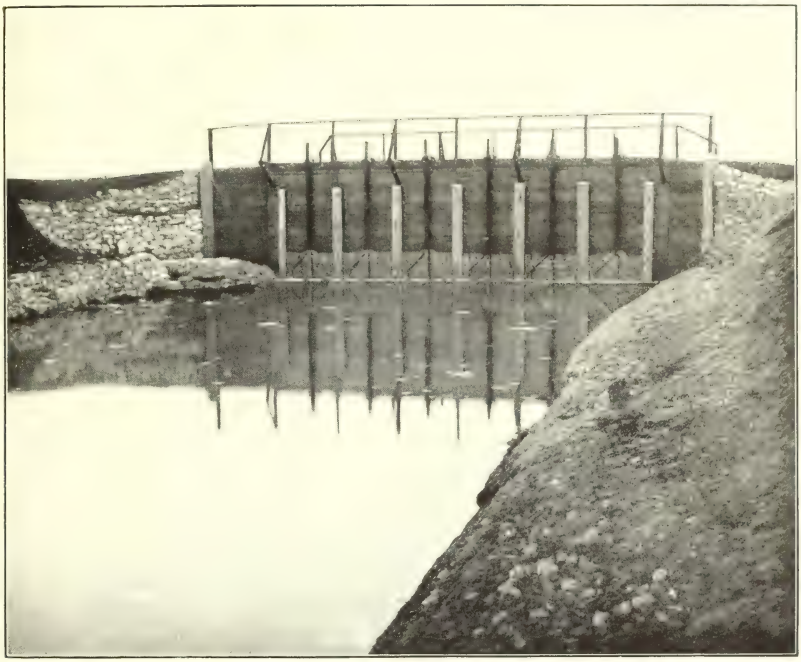


FIG. 4.—Map of Margueretta canal system.

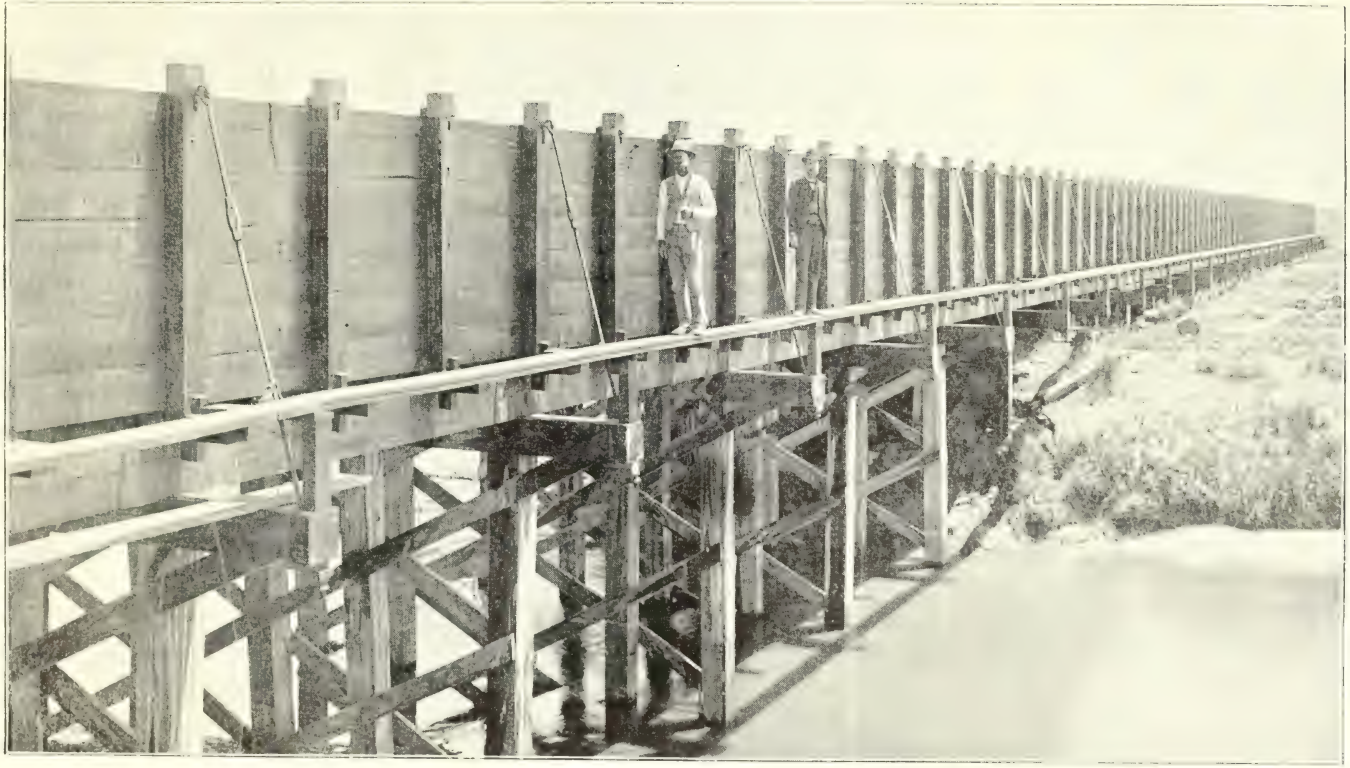
direction for 12 miles. There is also a branch continuing down the west bank for a considerable distance, being the main part of the old Pioneer canal and now known as the West Valley canal, a view of which is shown in Pl. II, *B*. Thirty current-meter measurements during 1900 show that this ditch carries an average of 12 second-feet of water. The dimensions of the main ditch are: Top width, 30 feet; bottom width, 18 feet; depth of water, 4½ feet. There are three principal laterals, with bottom widths of 12, 6, and 8 feet, respectively. In Pl. IV, *A* and *B*, are shown a sluice gate and a measuring weir used on the canal.

The canal was first used in 1889, and the extent of land irrigated



A. HEADGATE OF MARGUERETTA CANAL.

B. ROCK CUT IN CURVE OF WEST VALLEY DITCH, MARGUERETTA CANAL.



MARGUERETTA FLUME ACROSS PECOS RIVER

by it is steadily increasing. The total cost of the system was more than $150,000, and it is designed to cover about 40,000 acres, only 6,000 of which are, however, yet under cultivation. The water rights are sold at $10 an acre, a permanent right guaranteeing 25 miners' inches of water to the acre. The annual rental is $1 and $1.50 for each acre served with water. The principal crop is cotton, of which there are about 3,500 acres. The other crops cultivated are alfalfa, sugar beets, and all kinds of forage plants, fruits, and vegetables. Sugar beets tested in 1896 showed between 14 and 20 per cent of saccharine matter. Peaches, apples, and grapes do well. Cotton averages 500 pounds of lint to the acre. The annual rainfall is about 12 inches. Owing to the high elevation (2,700 feet) the seasons are much later than in most of the irrigated districts of the State.

The enterprise seems to have been conducted with energy and care, the canals and head gates are well planned and well built, and altogether the scene about Barstow, the center of the irrigated portion, has a general air of healthy growth and prosperity that is very pleasing to the eye after the many miles of desert scenery between there and El Paso. There are, however, a number of problems that must be solved before agriculture will be everywhere successful. Much of the land is impregnated with what is known as alkali. At first this does not prove troublesome, but after a few years of cultivation it may be brought to the surface by injudicious treatment, and the river water used in irrigation continually adds to the supply of this mineral matter. The only remedy so far applied is drainage, which is as important in its way as irrigation. The land is nearly level, and considerable care will be required to provide means by which the accumulated alkali can be washed from the soil.

One of the principal crops is alfalfa, which sells at $8 a ton on the cars at Pecos and $10 a ton retail. Alfalfa (*Medicago sativa*) will grow on almost any land, under almost any conditions, but satisfactory results can be expected only on a naturally deep, loose, porous soil, preferably deep sand, underlain with gravel, so that good drainage is assured.

PECOS RIVER IRRIGATION COMPANY.

About 28 miles below Pecos is the head gate of the canal of the Pecos River Irrigation Company, on the west side of the river, running in a general southeasterly direction for 12 miles. It is the oldest ditch on the river in Texas, having been built in 1875 and 1876. It was enlarged in 1889 and used again in 1890, but has never been entirely completed in its enlarged condition. It takes all its water by means of a brush-and-stone dam about 60 feet long and from 5 to 6 feet high. The total cost of the undertaking was about $35,000. It was designed to irrigate 20,000 acres, but only 100 acres were irri-

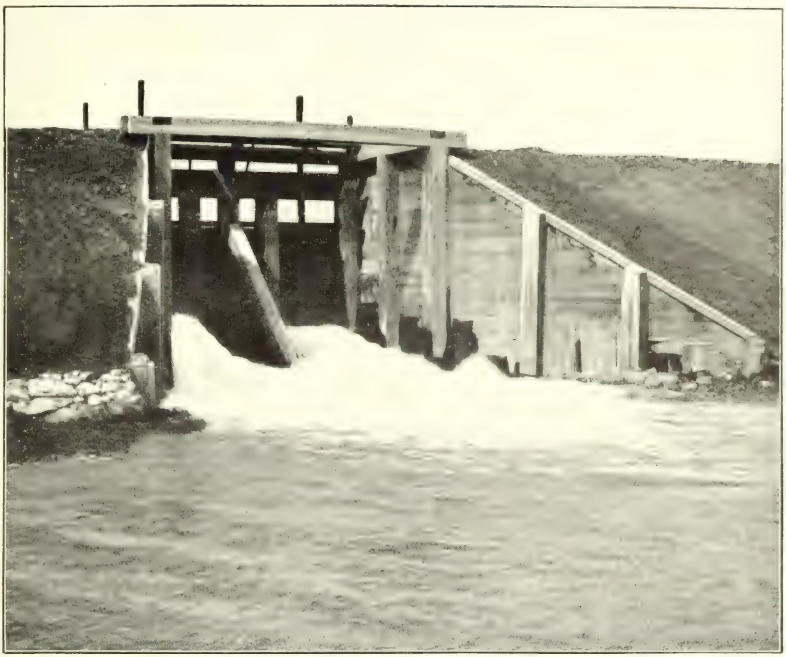
gated in 1901. The water supply was very short for several years, especially in 1892, 1893, 1894, and 1898, after the dam at Carlsbad, N. Mex., was completed. The flow has increased since then, but the river becomes quite low and the water bitter in March and April of each year. The soils and crops raised are similar to those at Pecos and at Barstow, but as at times only 15 second-feet of water are permitted to pass Pecos, the supply and quality are entirely inadequate to meet the demands.

GRAND FALLS.

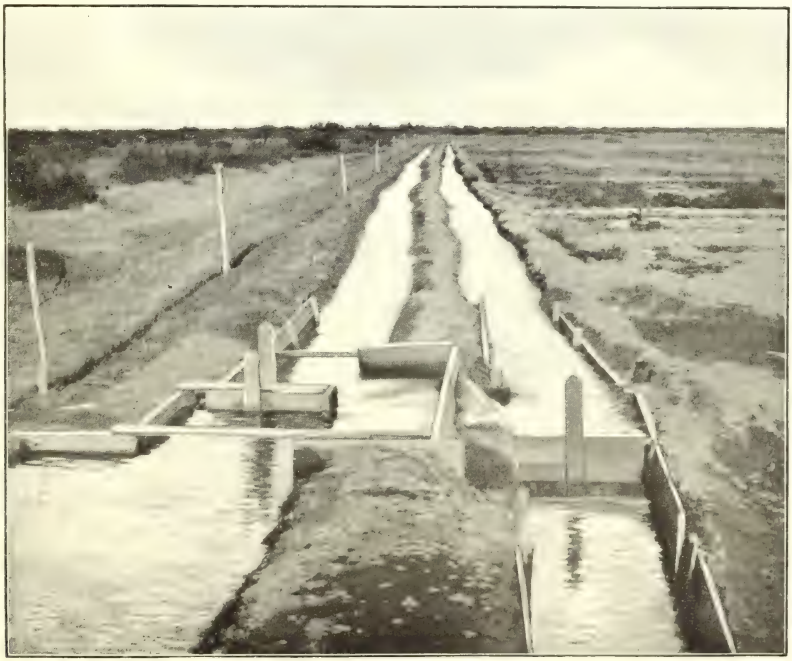
The Grand Falls Irrigation and Improvement Company takes out a canal 4 miles below the head gates of the one last described, but on the opposite side of the river. It was begun in 1896, and 16 miles of it are finished. It is supplied by a brush-and-stone dam across the

FIG. 5.—Map of Grand Falls and Santa Lucia irrigation systems.

river, 100 feet long and 7 feet high. The water rights are valued at $15 an acre; the annual assessment is $1.25 an acre. The company has completed an excellent system of canals in one of the most fertile valleys in Texas (see fig. 5), but the enterprise, like that of the Pecos River Irrigation Company, left two factors out of its calculations or gave them too little weight—i. e., the minimum flow of the river and the amount of alkali it carries at low stages. Both factors prove almost conclusively that only alfalfa can be raised on either side of the river near Grand Falls. The brackish condition of the water will affect the young alfalfa, but after it gets stronger it can stand it and water can be applied at will. By judicious management a small amount of alfalfa can be produced in paying quantities, notwithstanding the alkali in the water. The Pecos and Grand Falls systems have fallen far below expectations.



A. SLUICE GATE USED ON MARGUERETTA CANAL.



B. MEASURING WEIR ADOPTED BY PIONEER CANAL COMPANY.

EDWARDS PLATEAU SYSTEMS.

The Edwards Plateau comprises the region bounded by Colorado River on the north and northeast, by the International and Great Northern and the Southern Pacific railroads, and by Pecos River. The systems treated under this section are those included in the plateau and its foothills, including, in whole or in part, the systems in the counties of Valverde, Kinney, Edwards, Kimble, Menard, San Saba, and Kerr. From the foothills of the plateau numerous large springs gush forth from the limestone rocks, and many of these have been utilized for water-power and irrigation purposes. Springs occur at Lampasas (the Hancock and Hanna springs; volume, 15 second-feet); at Walton's ranch, near Bartlett; at Mormon Springs (volume, 10 second-feet), on the banks of the Colorado, 1 mile above the Austin dam; at Barton Springs, 1½ miles southwest of Austin (with a volume varying from 18 to 70 second-feet, the average being 30 second-feet); at San Marcos, forming San Marcos River (minimum volume, 70 second-feet); at New Braunfels (minimum volume, 300 second-feet), forming Comal River; at San Antonio, with a volume varying from 9 to 125 second-feet; at Uvalde, with a volume varying from 0 to 15 second-feet; at Brackettville (the Las Moras, with a minimum volume of 21 second-feet); at Del Rio, in the San Felipe Springs and Creek, with a minimum volume of 60 second-feet; along Upper Nueces River, in the Edwards Plateau; the Kickapoo Spring, in Tom Green County, etc. The systems treated here are those at Del Rio, including Cienagas Creek; those along Mud and Los Moras creeks; those along the Upper Nueces; those near Menardville; and those in Kerr, Kimble, and Edwards counties.

DEL RIO.

At Del Rio is one of the most effective and successful irrigation systems in Texas. A map of it is shown in fig. 6. The water is supplied from San Felipe Creek, a short stream formed by four large springs, about 1 mile east of the town, within a fourth of a mile of one another. In the 4½ miles from the springs to the Rio Grande the fall of the stream is 62 feet, thus furnishing an excellent water power for manufacturing purposes. Four ditches have been taken out, two of them for irrigation. They are supplied with water by means of two permanent masonry dams 65 and 150 feet in length, respectively, and each 8 feet high. The smaller dam, shown in Pl. V, *B*, is nearest the springs, and is the starting point of the San Felipe ditch, shown in Pl. V, *A*.

The first ditch was started in 1868 by James H. Taylor and others. The company purchased about 6,000 acres of land, including Cienagas and San Felipe creeks. In 1869 several hundred acres were irrigated from this ditch. The second ditch was taken out in 1869, with a capacity to serve 1,600 acres. The third was started in 1873; 2½ miles were built in 1874, and it was widened and completed in 1875. The

ditches are now owned by the San Felipe Agricultural, Mechanical, and Irrigation Company, the shares in which are held by owners of the land commanded by the ditches. The total cost of the ditches was about $25,000, and the annual cost of maintaining them is about 50 cents per acre per annum. The main ditches measure about 4½ miles in length and are 10 feet wide at the top, have perpendicular sides, and carry about 2 feet of water. The laterals are four in number, with an average width of 4 feet and a total length of 24½ miles, making the total length of the ditches 30 miles. The area irrigated is 3,600 acres (in meadow, cotton, corn, gardens, orchards,

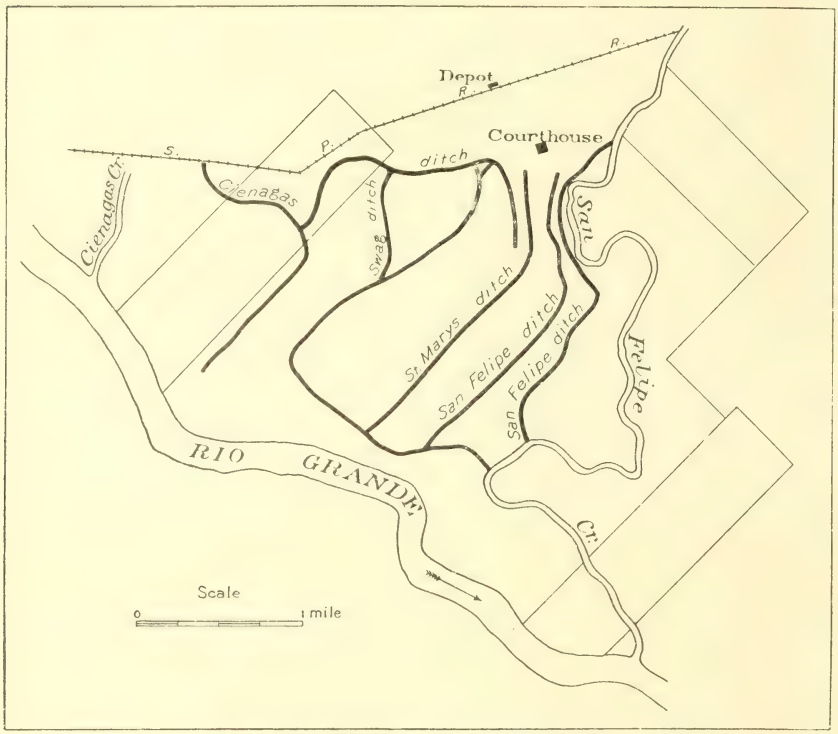
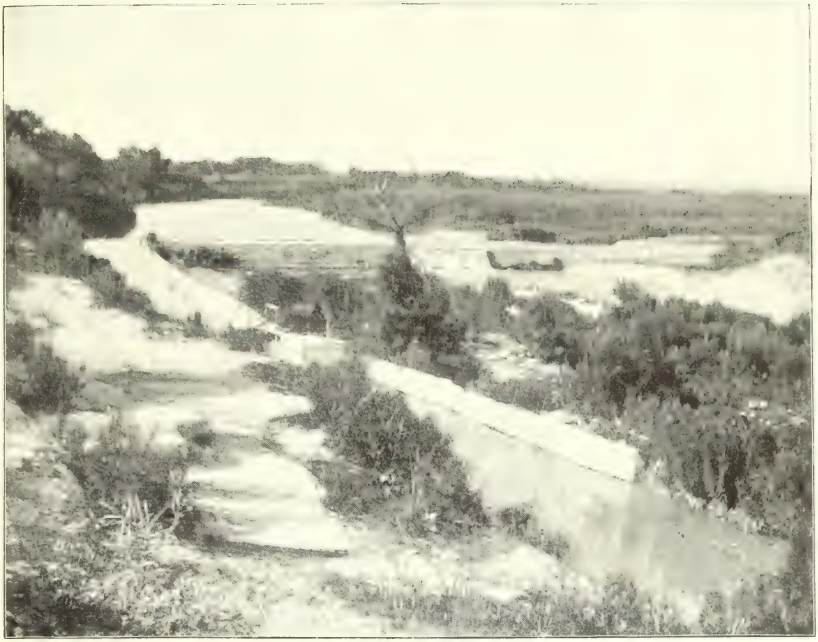


FIG. 6.—Map of Del Rio irrigation system.

and vineyards), although 5,000 acres can be irrigated. All kinds of fruits and vegetables are grown in profusion. On June 15 of this year (1902) melons, plums, and apples were ripe. The impression made on the traveler who comes from the droughty and sun-scorched plains is not soon forgotten. This cultivated tract has been so isolated from the rest of the agricultural world that none of the diseases which so reduce the profits of the grape and fruit grower elsewhere have yet been introduced. Grapes produce from 6,000 to 10,000 pounds to the acre, and are mostly made into wine, the yield of which is from 10 to 16 barrels to the acre.



A. DAM SUPPLYING SAN FELIPE DITCH AT DEL RIO.

B. DAM SUPPLYING MADRE DITCH AT DEL RIO.

CIENAGAS CREEK.

Cienagas Creek rises in the Cienagas Spring, in section 179, about 3 miles west of Del Rio. A dam 690 feet long and 25 feet high was constructed across the creek in 1875. This deflected the water into a ditch that skirted the foothills to the west, and then turned toward the east, after crossing the tracks of the Southern Pacific Railroad, as shown in fig. 7. The ditch is 3½ miles long, 6 feet wide, and 4 feet deep. The flow is sufficient to irrigate 800 acres. The principal crop is Johnson grass, which is raised for hay. The year 1900 was so wet

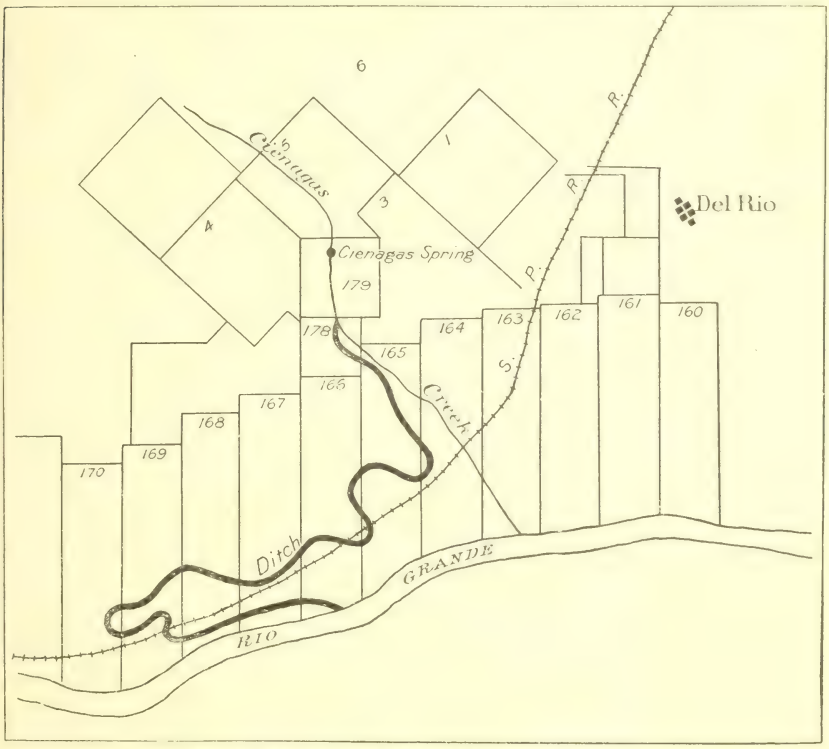


FIG. 7.—Map of Cienagas Creek irrigation system.

all over Texas that no irrigation was needed to produce an excellent hay crop. The hay farms lie along the Southern Pacific Railroad, between it and the Rio Grande. The yield in 1900 was 5 tons to the acre.

MUD CREEK.

Mud Creek, which is about halfway between Las Moras and San Felipe creeks, has had a varied history. Several attempts have been made to utilize its waters for irrigation purposes. The creek rises in large springs about 7 miles north of the crossing of the Southern

Pacific Railroad. At one time there was a dam across the stream just below the springs which backed the water over the springs, and it was claimed that this was one of the causes of the stream going dry. The dam was finally blown out, but the creek did not regain its former flow until the spring of 1900. It was practically dry from 1893

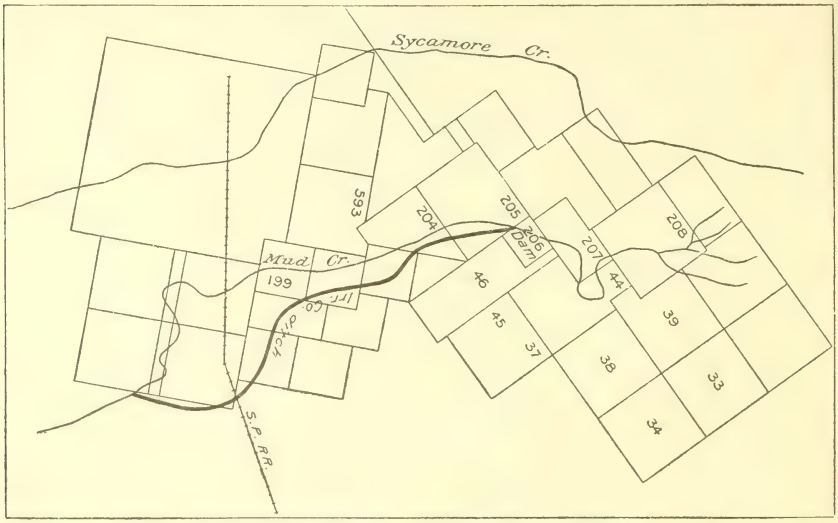


Fig. 8.—Map of Mud Creek irrigation system

to 1899. Its revival was simultaneous with the revival of the Leona and San Antonio rivers. A ditch, shown in fig. 8, is taken out of the creek on its west side 3 miles above the railroad, and in 1900 about 400 acres were irrigated from it.

LAS MORAS CREEK.

Las Moras Creek rises in large springs near Brackett. The flow in 1895 was 21 second-feet, and in 1900 it was 51 second-feet. The waters of the creek are used for irrigating farms and gardens within 10 miles of Brackett.

Government ditch.—The ditch nearest to Brackett, shown in fig. 9, is the property of the Government, being used by the Seminole Negro Indians, who live on the Fort Clark Reservation. It is on the west side of the creek, and is about 1 mile long, 5 feet wide, and 1 foot deep.

Indelkofer-Gilder ditch.—The Indelkofer-Gilder ditch, also on the west side of the creek, is taken out 1 mile below the intake of the Seminole ditch. Its dimensions are: Length, 600 feet; width, 4 feet, and depth, 1 foot; 15 acres are irrigated from it.

McGovern ditch.—The McGovern ditch, from which 8 acres are irrigated, is taken out on the east side a short distance above the intake of the Indelkofer-Gilder ditch. Its length is 600 yards, depth 1 foot, and width 5 feet.

Smith and Stratton ditches.—About 6 miles below Brackett two ditches—the Smith and the Stratton—are taken out, one on the west and the other on the east side of the creek. The Smith ditch is 600 feet long, 4 feet wide, and 1 foot deep, and irrigates from 6 to 10 acres of garden. The Stratton ditch is 3 miles long, 8 feet wide, and 1 foot deep, and irrigates a hay farm of 250 acres below the Southern Pacific Railroad. In March, 1902, through litigation, Judge Stratton lost part control of the ditch which bears his name, and he therefore abandoned it and installed a pumping plant on the Las Moras. This

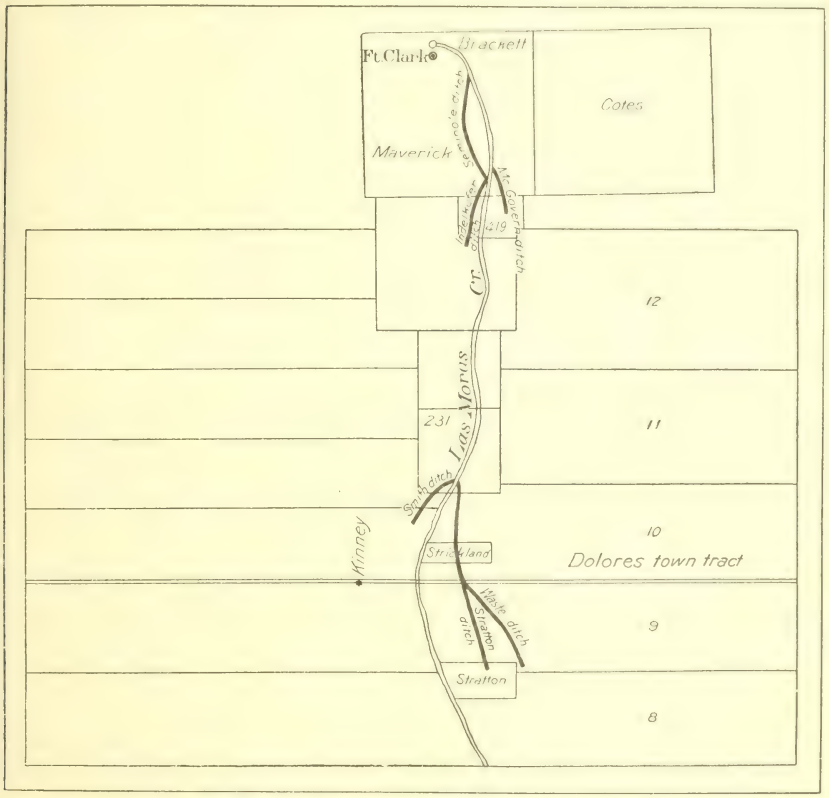


FIG. 9.—Map of Las Moras Creek irrigation systems.

plant can readily be seen from the Southern Pacific trains as they near the bridge on the Las Moras. The machinery consists of a 40-horsepower Ames steam engine, which operates an 8-inch Gould centrifugal pump against a lift which varies from 17 to 20 feet. Eagle Pass coal is used for fuel, and it requires 2,500 pounds for a complete day's run. The capacity of the plant is 4,750 minute-gallons, and in very dry seasons it exhausts the twenty-four hours' impounded flow of the Las Moras in two and a half hours. A small dam is constructed across the stream, which forms a reservoir in the channel, and is allowed

to impound the water in irrigation season for twenty-four hours. The water is delivered into a flume 15 by 30 inches, 2,000 feet long, which carries it to the highest point of the land. Johnson grass is the main crop, and three crops are made each season, averaging 2 tons to the acre, which in August, 1902, was selling for $14 a ton. This is somewhat higher than usual, but it never sold for less than $11 a ton.

SAN SABA VALLEY.

The San Saba River rises in springs 1½ and 3 miles above Fort McKavett. The total flow of these at the crossing a mile below town was found on August 14, 1902, to be 13 second-feet. There are in all eleven different irrigation systems in Menard County that take their water from the river or the springs that feed it. These are the Ball, Perry, Byers, Dickinson, Striegler, Spitgarber, Coghlan, Noyes, Sieker, Kitchen, and Vanderstücken.

Ball system.—The plant of Tom Ball is north of Fort McKavett and takes its water from the San Saba by means of a pump run by a 20-horsepower steam engine. It is intended to irrigate 50 acres.

Perry system.—Seven miles east of Fort McKavett, on the south side of the river, W. J. Perry irrigates 30 acres from the Sheen spring, which comes out of the foothills in a flow of 1 second-foot. This system has been in operation a long time, and double the acreage could be brought under irrigation.

Spitgarber and Coghlan systems.—At the Spitgarber ranch, 6 miles above Menardville, there is a bold spring flowing out of the foothills. A ditch taps this spring and irrigates 20 acres. One mile above the Spitgarber ranch, on the Coghlan ranch, occurs another spring. A ditch taps the outflow of this spring and irrigates 40 acres.

Byers systems.—Twelve miles above Menardville is Byers's vineyard. The dam is almost as unique in construction as that of Captain Sieker. Into the rock bottom holes were drilled across the river and small iron posts were inserted. An iron brace was attached to each post, the other end of the brace fitting a hole drilled into the rock bottom. A plank was attached to the upper side of each post and adjusted to fit the configuration of the river bed. On the top of this bottom plank another plank was placed and attached to the posts. The race was blasted out of the solid rock on the north side of the river. Two stone piers were built up to form supports for the axis of the undershot water wheel. To the wheel are attached buckets which carry a certain amount of water to the level above, and in addition the wheel is made to operate a pump which reinforces the flow from the buckets. This plant irrigates a vineyard, the fruit of which is converted into wine. A half mile below this vineyard is the plant of the younger Byers, which is similar to that just described.

Clear Creek systems.—Clear Creek, 3 miles long, issues from the mountains in a bold spring, which had a capacity on August 14, 1902,

when measured, of 21 second-feet. The owner, W. J. Wilkinson, a settler of forty years' residence, states that during the summer the flow is larger than it is during the winter. The waters are used by two small irrigation systems, the Wilkinson and the Striegler. A small rock dam at the head deflects part of the waters into the two ditches of the Wilkinson system, from which 12 acres are irrigated on each side of the creek. Near the mouth of the creek O. Striegler, by means of a rock dam 8 feet high and about 50 feet in total length, that deflects the water into a ditch on the left side of the creek, irrigates 18 acres in corn, cotton, oats, melons, etc. It is well to remember that the capacity of this creek was exactly three-fourths of that of the Noyes ditch near the courthouse in Menardville on the same day.

Old Mission ditch.—The San Saba mission was established at what is now known as old Fort San Saba in 1734, and it was from this the river took its name. The Franciscan fathers who established the mission constructed a system of irrigation the remains of which can

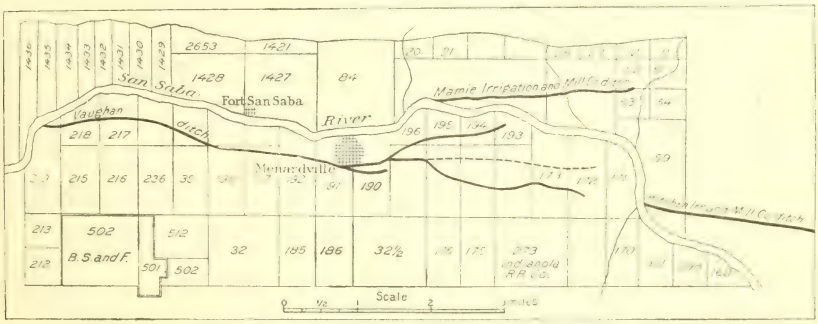


FIG. 10.—Map of Menardville irrigation systems.

be easily traced to-day. The dam was a short distance above the mission and the ditch was taken out on the south side of the river and skirted the hills one-half mile above Menardville.

There are three systems near Menardville—the Vaughan, the Sicker, and the Kitchen. (See fig. 10.)

Noyes ditch.—The Noyes ditch is nearly 10 miles long. The dam is built across San Saba River about 4 miles above Menardville, and the water returns to the river 5 miles below that town. The charter was obtained by the Vaughan Agricultural and Improvement Company in 1874, and the ditch was built soon after. It is claimed that this company put $12,000 into the work. This was an excessive cost, extra expense being incurred by the refusal of right of way in one instance, forcing the company to make a cut 16 feet deep and several hundred feet long. Further, the methods employed were rude and costly. Wheelbarrows were used to move the dirt, and in the cut the earth was thrown on staging and passed from man to man. There are 97 shares of stock, valued at $180 each. One year $1,200

was spent in improvements and another year $1,000, but the ditch pays all running expenses, cost of improvements, and 10 per cent on the shares at the foregoing valuation.

After construction the grade of the ditch was found to be irregular and unsuitable, so work has been done each year—cutting and filling—to reduce the slope above the Las Moras flume to a nearly uniform grade of 30 inches to the mile. At the flume there is a fall of 14 inches in 128 feet. At the point of the mountain, where the ditch curves with the hill and runs through rock, it is lessened in size and has a much steeper grade. The grade of 30 inches to the mile was established experimentally and satisfies as nearly as possible the necessity of avoiding silting on the one hand and erosion on the other. The ditch runs through coarse gravel part of the way, and there is a heavy loss from percolation. The straightening of the ditch, the reduction of the grade, and the tightening of the dam have given an available flow of water sufficient to irrigate 2,000 acres of land.

The dam is of rough limestone quarried at the spot, averaging, where seen on the front, 2 feet by 3 feet by 10 inches, and laid in courses without cement. The blocks are tied by bolts fastened to a log under the dam, passing up through the dam, and at the top are fastened by taps to cross-ties lying along the upper surface. The dam is slightly concave, and is about 200 feet long and 5½ feet high at the center of the front, with an irregular batter. It is 13½ feet wide on top at the center. It rests partly on rock and partly on gravel, and is backed with earth on a slope of nearly 2 to 1.

The water stands within a few inches of the top of the dam and overflows at every rise in the river. Judging from the high-water marks there are 10 or 12 feet of water passing over it at times. Below the dam is a pile of loose bowlders which holds the leakage through the dam and forms a water cushion to receive the fall. At every high rise the dirt is washed from the back of the dam, and when the water subsides it is at once replaced by dirt scraped from the north side of the river. The dam backs the water about 500 yards, the deepest hole being about 15 feet. The water is taken out on the south side, 100 or more yards above the dam, and is carried in a cut to the sluice gate a short distance below the dam.

A section of the ditch made a few hundred yards below the sluice gate gave the following dimensions: Top width, 15.2 feet; bottom width, 8 feet; depth, 2.7 feet; wetted perimeter, 16.5 feet; area, 29.83 square feet; maximum surface velocity, 2.17 feet per second, and mean velocity, 1.54 feet per second. The velocity was measured for 100 feet above and below the section, where there was not a very great difference in the dimensions of the ditch. The fall of the surface was found to be 0.1 foot in 195, or 1 foot in 1,950, or 2.7 feet in a mile. This, with a coefficient of $n=0.03$, would give a velocity of 1.57 feet per second, which is very near the observed velocity of flow, and

gives a discharge of 46 cubic feet per second, or 2,300 inches, estimating 50 inches to 1 foot.

The flow of the main ditch was measured by current meter in August, 1902, at the bridge near the Methodist Church and it was found to be 28 second-feet. Two small ditches, one on the north side of Main street and the other skirting the foothills of the south, taken out above the bridge referred to, were carrying one-third and 1 second-foot, respectively.

As to the amount of water required to the acre, one man who irrigates 40 acres of land uses 40 inches of water and occasionally needs a little more. On another farm they use 15 inches of water on 12 acres of garden truck. On the upper part of the ditch above the town the water is measured and distributed by the inch; that is, if a man wants 20 inches of water the gate opening on his ditch is set for a 20-inch flow and remains in that position throughout the season. From the town down they use the water in rotation, because, owing to a mistake in laying out the distributaries, the use of water above interferes with the flow below. So they alternate every seven days, the residents above using all the water that reaches them during that period, the lower owner having all the water during the next seven days. One-half mile below the town the Waller lateral runs off to the left toward the river bend. At present (1902) it is the custom to let those on the Waller have the whole flow one week and those on the main ditch the next, etc.

Assuming the acreage irrigated to be 2,000 acres, we have from our calculated flow a little more than 1 inch to the acre, which is the allowance in actual use, and a duty of 44 acres per cubic foot per second of flow for the water entering the main ditch. These measurements were made at but one point, and can be considered only approximate for the whole ditch. For accuracy they should be repeated at a number of points and proper allowance be made for percolation and leakage. In general, the estimate is that three waterings of 4 inches will make a crop.

Sieker system.—One mile below Menardville is the dam of Capt. L. P. Sieker. It is of peculiar construction, as shown in fig. 11. In a line across the river piles 6 feet apart were driven into the bed of the river with a pile driver, being left 5 feet above the river bottom. Parallel to this row and 6 feet from it another row of piles was driven in such a way that the piles of the lower row were immediately below those of the upper row. The piles were thus located at the corners of 6-foot squares. The piles of the lower row projected only 3 feet above the bed of the river. Sheathing boards 2 inches thick were spiked on the upper side of the upper row of piles, while logs were laid against the upper side of the lower row of piles and were wired to them. The inclosure between the sheathing and the logs was filled with loose stone. This added weight and increased the stability

already obtained by sinking the piles. To prevent leakage cedar tops were piled above the dam and were tramped into the soil and against the dam. On top of the cedar boughs earth was filled to within a short distance of the top. This method of constructing a dam has proved very successful. The dam is 380 feet long, 5 feet high, and 6 feet wide.

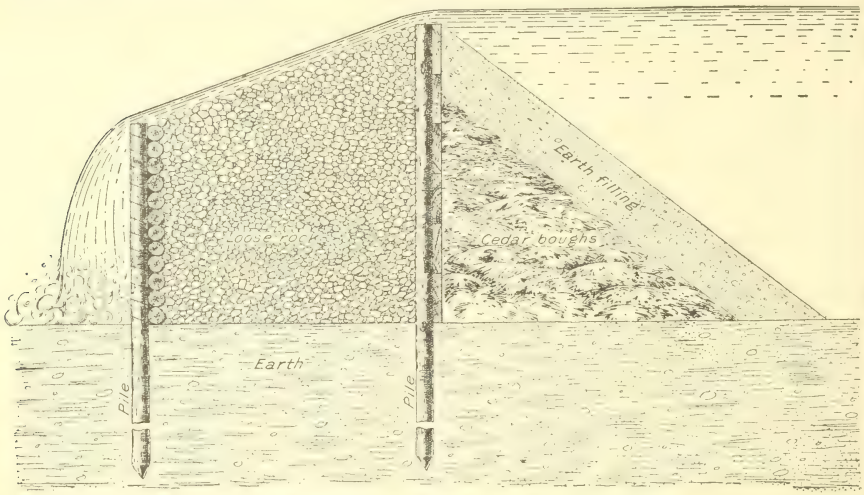


FIG. 11.—Cross section of Sicker's dam on San Saba River.

From the lake thus formed leads the ditch known as the Mamie ditch, built in 1894. It was chartered for a length of 4 miles, but only $1\frac{3}{4}$ miles have been constructed. It is 6 feet wide and 2 feet deep. At one place it is forced to within 30 feet of the river, on account of the foothills crowding up to the river bank. The cut at this place was 18 feet deep and the bottom of the ditch 9 feet above

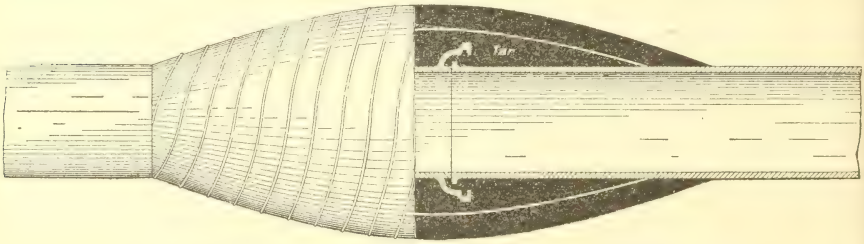


FIG. 12.—Flexible pipe joint used on the Mamie ditch.

the ordinary water level of the river. One hundred and seventy-five acres are irrigated from the ditch, but it has a capacity of 200 acres. The chief crops are cotton and corn. Cotton averages from $1\frac{1}{2}$ to 2 bales and costs $1.25 a bale for transportation to the railroad. Corn brings from 15 to 20 cents more a bushel than at the markets on the railroad. Sweet potatoes average 250 bushels to the acre.

The ditch crosses four streams, Millers Branch, Temple Branch,

Temple Field Creek, and Scalp Creek. At first the old form of wooden flume was used across these creeks and branches, the channels being 4 feet wide and 2 feet deep, but the excessive heat of summer caused constant leaks in the flumes, and they were finally abandoned as water carriers. The sides were taken off and the floors were left as supports for the pipe lines which were substituted to carry the water across the creeks. To counteract the expansion due to the heat a flexible joint, shown in fig. 12, was designed to connect the sections of the pipe. After the ends were brought together several inches of the pipe near the joint was heavily coated with North Carolina tar, heavy canvas was wrapped around the joint, the whole was again tarred, and the canvas was securely strapped to the pipes by wires twisted around the joint. A bulkhead was constructed across the ditch on each side of the creeks and the pipes were built into the bulkheads. At Millers Branch the flume pipe is 90 feet long, 18 inches in diameter, and has a fall of 14 inches; at Temple Branch the length of the pipe is 50 feet, its diameter 15 inches, and the fall 9 inches; the Temple Field flume pipe is 125 feet long and 12 inches in diameter, and the fall is 18 inches; at Scalp Creek the length of the pipe is 180 feet, its diameter 13 inches, and the fall 18 inches. All of these flexible joints and pipe flumes have proved eminently satisfactory.

Kitchen ditch.—This ditch is taken out 6½ miles below Menardville and 5½ miles below the Sicker or Mannie dam. The dam is of brush, rock, and dirt, about 75 feet long and 7 feet high. The ditch leading from the lake formed by the dam is 4½ miles long, 6 feet wide, and 2 feet deep. Three hundred acres were irrigated from it in 1902.

Vanderstücken system.—Twelve miles east of Menardville, on San Saba River, is a pumping plant owned by Emile Vanderstücken, consisting of a 28-horsepower steam engine operating by a belt a Van Wie centrifugal pump having a capacity of 5,000 gallons a minute, or 11 second-feet, with a lift of 31 feet. The total cost of the plant was $1,500. No reservoir is used, the water being carried in a flume to the highest point on the land and distributed by ditches. The flume runs along a ridge for 150 feet and then branches.

Sloan system.—At Sloan, San Saba County, there is a series of perennial springs that gush forth from the foothills near San Saba River. Originally the water ran down to the low grounds and formed a pond, but about 1870 a ditch was constructed along the foothills to the river, which took the water away from the pond, and it soon dried up. A stone dam 200 feet long and 4 feet high was built to deflect the water into the ditch. The ditch shown in fig. 13 is 1 mile long, 5 feet wide, and 1 foot deep. The former pond is now an irrigated farm, through which runs a long sag. To convey the water across this sag a rock race and a pine and cypress flume are used. The soil is a rich, black loam, slightly sandy. The crops raised are corn, cotton, ribbon cane,

and sweet potatoes. The yield per acre is generally from 40 to 60 bushels of corn, from 1 to 2 bales of cotton, about 290 gallons of molasses, and from 150 to 300 bushels of potatoes. The ditch is owned by Mr. J. A. Sloan & Sons, and in 1902 it irrigated 186 acres.

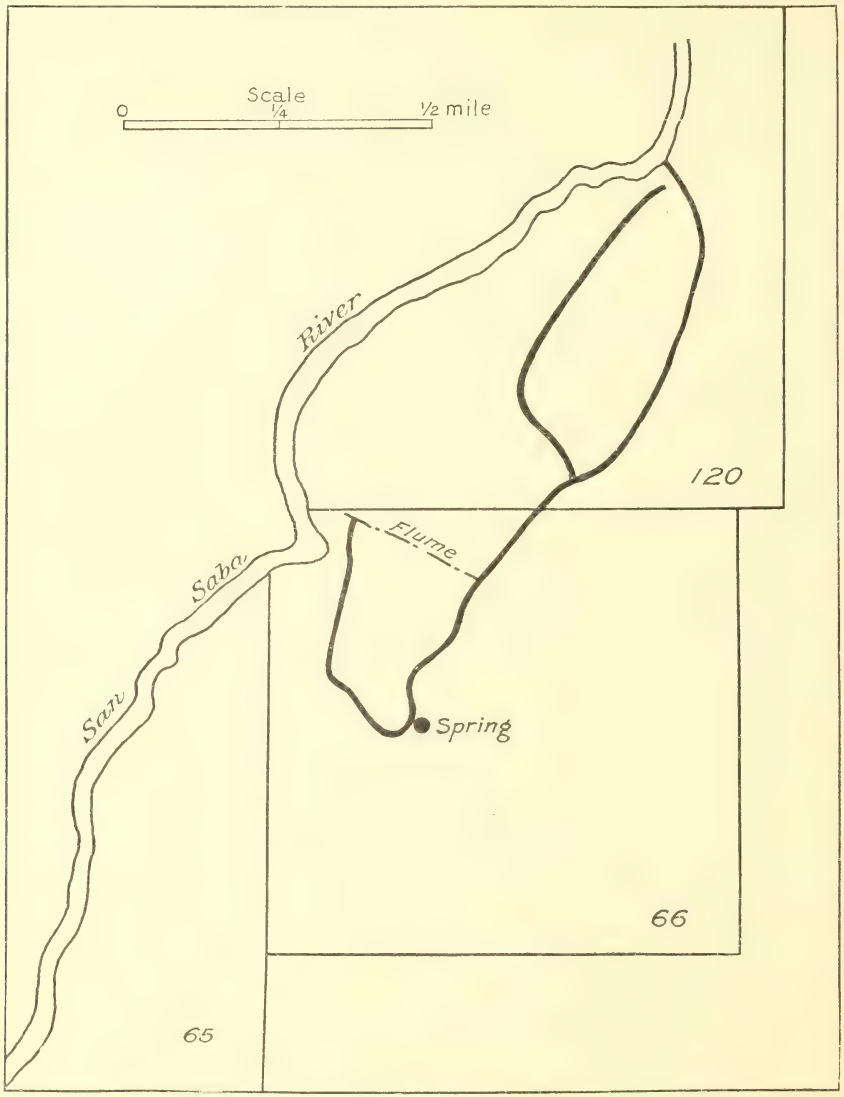


FIG. 13.—Map of Sloan irrigation system.

Doran system.—Seventeen miles west of the town of San Saba is the irrigation plant of W. R. Doran. The water is drawn from the river through a ditch 600 feet long into a pond from which it is pumped into the flume. A 16-horsepower engine runs a centrifugal pump against a lift of 28 feet, delivering 2 cubic feet per sec-

ond. One hundred acres (in cotton, millet, cane, and corn) are to be irrigated.

West & Burnet system.—Ten miles northwest of San Saba West & Burnet have constructed an impounding reservoir of an estimated capacity of 20,000,000 gallons, by making a dam across a drainway. The dam is 705 feet long, 14 feet high, and cost nearly $1,000. The ordinary crops will be irrigated and the number of acres the canal will serve will be determined by trial.

King system.—Probably the oldest irrigation plant in the San Saba country is that of the King Sisters (Larkin King, manager), just above Sloan, on the south side of the river. There are two springs, known as the Fleming Springs, that issue from the foothills of the mountains and supply the King farm with sufficient water to irrigate 40 acres.

Ellis system.—Twelve miles above San Saba, on the south side of the river, Robert Ellis operates a pump irrigation plant, which was first erected late in the season of 1902. A stationary tubular 25-horsepower boiler furnishes steam to a 20-horsepower engine, which drives a 6-inch Rumsey pump against a lift of 25 feet. The water is pumped out of a walled-in well 6 feet in diameter and 19 feet deep from top of curbing, the well being supplied from the San Saba River by a 15-inch wooden pipe, constructed of leveled 2 by 4 pine lumber. The water is pumped into a canal that conveys it to the fields one-fourth mile from the pump. Ordinary crops of corn, cotton, etc., are irrigated.

Hawkins system.—Eight miles above San Saba, on the farm of Mrs. M. E. Cook, Thomas Hawkins has equipped a pumping plant by a 12-horsepower charter gasoline engine, which runs a 4-inch vertical Van Wie centrifugal pump against a lift of 33 feet. The plant cost $825, and with it, by the use of $4 worth of oil, 6 acres can be irrigated by the furrow system each day. By this plant 40 to 50 acres can be irrigated each season.

Proposed canal system.—Many surveys have been made with the view of putting in an irrigation system on a large scale in the San Saba Valley. Seventeen miles above the town of San Saba, at the Narrows, the river issues from the canyons which it has traversed for a distance of 60 miles, from a point about 12 miles below Menardville. From the Narrows to the junction of the San Saba and Colorado a fertile valley on each side of the San Saba River could easily be brought under irrigation. The flow of the San Saba at the Narrows, as determined by two measurements in June, 1902, by the writer, at a time when no rain of importance had fallen in its watershed for two years previous, was found to be 24.5 second-feet. To irrigate the 42,000 acres in the valley below, a system of storage reservoirs could easily be constructed by putting in dams across the river at the Narrows and near the mouth of Brady Creek. The deflecting dam at the Narrows would be about 550 feet long and 60 feet high to fill the north valley canal, which would bring under

ditch all of the north valley between Doran's ranch and the Colorado. Two distinct surveys have been made by independent parties with the view of putting in a complete irrigation system in this valley. The soil is rich, and the possibility of irrigating the lands in the valley by storing up the flood waters in the deep canyons offers easy construction for the prospectors. Between the deflecting dam and Menardville there would be no adverse interest to complicate the situation, as there are no farming lands in this section of the river to be covered.

Systems east of San Saba.—Just east of San Saba there is a large tract of land extending from the mill creek that skirts the town to the foothills 3 miles east. This land could be irrigated easily, and offers an inviting field. From the lake formed by the dam across the creek a stone race leads out into a ditch that commands several hundred acres. The ditch is 2 miles long and is well built, as is shown by the substantial flume about one-fourth of a mile from the dam, which was used to carry the water across a sag. This ditch has not been utilized for two or three years, but it is reported that it will be brought into use again for the season of 1902. Near the foothills east of San Saba an effective spring, known as the Barnet Spring, furnishes sufficient water to irrigate the lands of Hambert Brothers and those of Mrs. Farrar. The ditch is a small surface trench, and could be rendered much more effective by repairs.

Maxwell system.—Twelve miles southeast of San Saba, on Rough Creek, Z. T. Maxwell has an irrigated farm of 40 acres, the water for which is supplied by perennial springs on the mountains. The water is conveyed from the springs by a ditch 1,500 feet long, which is tapped by three side ditches. The main ditch has a fall of 1 foot in every 300, while the side ditches have a fall of 1 foot in every 600. The soil is partly black loam and partly chalky and sandy. The farm has been in operation since 1880, and is one of the most successful in Texas. The crop in 1901 was distributed as follows: Twenty-one acres of onions, 2 acres of cabbages, 2 acres of tomatoes, 10 acres of millet, 5 acres of cane, and the remainder in corn, wheat, etc. A second crop is raised on the small-grain and the onion land. In 1901 the onion land yielded 180 bushels to the acre and a second crop of 50 bushels of peas to the acre.

Baker system.—Near Sloan post-office, on Richland Creek, a tributary of San Saba River, about 30 miles northwest of the town of San Saba, George Baker has a system of ditches from which he irrigates 150 acres, the principal crop being cotton. The water is taken from the Richland Spring by a cement and stone dam 25 feet long and 5 feet high. There are 2 miles of ditches on both sides of the creek, the width and depth of which are 4 feet and 2 feet, respectively. The plant was inaugurated in 1870, and the yield from the black and waxy valleys on each side of the creek is from 1½ to 2 bales of cotton to the acre.

UPPER NUECES.

There are several small irrigation plants in Edwards and Uvalde counties, on the prongs of Nueces and Frio rivers, in the vicinity of Leakey, Barksdale, Vance, Riofrio, Montell, and Laguna. The following persons have irrigation plants: Tom Woods and M. Clymer, near Rock Springs; W. B. Patterson and H. Elms, near Leakey; W. D. Hutcheson, O. A. V. Burr, John Nelson, M. Red, J. W. Sparks, W. F. Woodward, S. W. McLaughlin, Mrs. W. A. Connell, W. A. Shockley, J. K. Lippard, B. F. Casey, J. H. Woods, and E. M. Jones, near Barksdale; Z. H. Pannell and A. R. Barker, near Vance; W. T. Patterson, near Riofrio; J. H. Etheridge, at Montell, and William Landrum, at Laguna.

Woods system.—The Tom Woods plant is a small one on the Pulliam Prong of Nueces River. It was built in 1883. The dam, which is 150 feet long and 1½ feet high, deflects the water into the ditch. It is made of logs, rock, and dirt. The ditch is 600 yards long, 2½ feet wide, and 1 foot deep. The soil is black alluvial along the banks of the stream, and 8 acres are irrigated and planted in corn, potatoes, cane, and Johnson grass. The yields per acre are as follows: Thirty-three bushels of corn, 200 bushels of potatoes, 2 tons of cane, and from 3 to 4 tons of Johnson grass. About 1 acre is sublet to another party for a garden.

Clymer system.—The plant of M. Clymer was constructed in 1897, and consists of a ditch 1,300 feet long, 2 feet wide, and about 1 foot deep. It takes its water direct, without the aid of a dam, from Hackberry Creek, a tributary of the East Prong of Nueces River. The soil is a black loam, 4 acres of which are irrigated for garden truck.

Hutcheson system.—W. D. Hutcheson, near Barksdale, has two ditches, both of which take their water from the South Prong of Campswood Creek, a tributary of Nueces River. The first ditch was taken out in 1889, on the east side of the creek. It is 500 yards long, 2 feet wide, and about 1 foot deep. It takes its water from the creek without the aid of a dam. The second ditch was built in 1893, on the west side of the creek. It is 400 yards long and of the same general dimensions as the first ditch. The water is deflected into it by a rock-and-earth dam 20 feet long and 3 feet high. The first ditch irrigates 7 acres and the latter 13 acres. The soil is a rich, black loam, and readily produces 40 bushels of corn or 1 bale of cotton to the acre.

Nelson system.—John Nelson's plant was inaugurated about ten years ago. It is near the post-office of Barksdale, on the South Prong of Campswood Creek. The dam is of logs, stones, and earth, is 30 feet long and 4 feet high, and deflects the water into the ditch. The latter is taken out on the left bank, is 600 yards long, 25 feet wide, and about 1 foot deep, and irrigates 150 acres in corn, potatoes, and cane, yielding 40 bushels of corn, 280 bushels of potatoes, and 5 tons of cane to the acre.

Red system.—The ditch of M. Red is on the South Prong of Campswood Creek, near the Barksdale post-office. It is 625 yards long, 2½ feet wide, and of an average depth of 1 foot. It was constructed in 1890, and takes the water from the stream by means of a log, stone, and dirt dam 18 feet long and 2½ feet high. Twenty-three acres of black, porous limestone soil, in corn, potatoes, cane, and vegetables, are irrigated. The yield per acre is 40 bushels of corn, 225 bushels of sweet potatoes, and 5 tons of cane.

Sparks system.—The ditch of J. W. Sparks is taken out just below that of M. Red, but on the opposite side of the creek. It is 2,100 feet long, 2 feet wide, and 1 foot deep, and irrigates 22 acres. The dam is made of logs, stone, and dirt; is 20 feet long and 2 feet high. The soil is black, and produces 1 bale of cotton, 40 bushels of corn, and 280 bushels of sweet potatoes to the acre.

Woodward system.—The system of W. F. Woodward, which is just below that of Mr. Sparks, on Campswood Creek, was constructed in 1895, and irrigates 25 acres of black, loose limestone soil in the usual crops of this section (corn, potatoes, and sorghum), the yield per acre being 40 bushels of corn, 300 bushels of potatoes, and 5 tons of sorghum hay. The dam is 24 feet long and 2 feet high, and deflects the water into a ditch 2,100 feet long, 2½ feet wide, and 1 foot deep. It is taken out of the left bank, but crosses to the right bank.

McLaughlin system.—S. W. McLaughlin's ditch is just northwest of that of W. F. Woodward, and takes its water from the left bank of Campswood Creek, by a dam of logs, stone, and dirt 40 feet long and 3 feet high. The ditch is 1,950 feet long, 2½ feet wide, and 1 foot deep. The soil is similar to that of the preceding plants, 14 acres of which are irrigated in the three chief crops of the Barksdale section—corn, sweet potatoes, and sorghum.

Connell system.—On the farm of Mrs. W. A. Connell there occurs one of the springs (Connell Spring) that really are the source of the water of the upper sections of Nueces and Frio rivers. Its waters are led off into a ditch 800 feet long, 2½ feet wide, and 1 foot deep, which irrigates 24 acres, in corn and potatoes. The spring is near a stream, and the ditch runs parallel to the stream for about half its length and then crosses by a flume to the right bank.

Shockley system.—The next ditch below that of Mrs. Connell, on the short spring branch that is tributary to the East Nueces, is that of W. A. Shockley. The water is taken from the branch by means of a dam of logs, stone, and dirt 20 feet long and 2 feet high. The ditch is 2,700 feet long, 3 feet wide, and 1 foot deep. The system was constructed in 1894, and 50 acres are irrigated, the yield being 35 bushels of corn, 275 bushels of potatoes, and 5 tons of cane to the acre. Messrs. Woodward and Cunningham are joint owners with Mr. Shockley.

Lippard system.—The plant of J. K. Lippard, at Barksdale post-

office, was erected in 1892, and consists of a stone-and-dirt dam 15 feet long and 1 foot high across Campswood Creek and a ditch 1,500 feet long, 2 feet wide, and 1 foot deep. This plant irrigates 12 acres of the black, porous limestone soil planted in corn, sweet potatoes, and sorghum, producing 35 bushels of corn, 275 bushels of potatoes, and 5 tons of cane to the acre. The ditch is taken out of the left bank of the stream, but crosses the creek by a flume, thus irrigating land on both sides.

Casey, Taylor, and Graham system.—B. F. Casey, M. M. Taylor, and Oscar Graham (Barksdale) are the joint owners of a ditch that was constructed in 1898 to take water from a short spring branch tributary to the East Nueces. The ditch is 1½ miles long, 4 feet wide, and 2 feet deep, and irrigates 40 acres, the yield per acre being 40 bushels of corn and 1 bale of cotton. The dam is of logs and dirt, 40 feet long and 3 feet high.

Burr and Woods systems.—On the Pulliam Prong of the Nueces O. A. V. Burr and J. H. Woods each took out a ditch in 1899. That of the former is a half mile long, 2 feet wide, and 2 feet deep, and irrigates 50 acres of black bottom land, which yields 30 bushels of corn, 1 bale of cotton, 5 tons of cane, and 280 bushels of sweet potatoes to the acre. The dam is of rock, 150 feet long and 6 feet high. About one-fourth mile below the Burr dam is the dam of Mr. Woods. It is of logs, dirt, and brush, 50 feet long and 2 feet high. The 12 acres irrigated produce the usual yield of corn, cane, and potatoes.

Jones systems.—E. M. Jones, at Barksdale, built two small ditches in 1893. The upper is 600 feet long, 2 feet wide, and 1 foot deep, and irrigates 2 acres. The brush-and-dirt dam is 10 feet long and 3 feet high. The lower ditch is of the same length and dimensions and irrigates the same amount of land as the upper ditch.

Elms system.—The system of H. Elms is near Leakey, on the Rio Frio. It was constructed in 1894, and consists of a ditch on the east side of the river 1½ miles long, 4 feet wide, and 2 feet deep. The dam is of dirt and stone, 40 feet long and 1 foot high. Forty acres of corn, cotton, and sorghum are irrigated, yielding the usual quantities for this section.

Patterson systems.—About 4 miles northeast of Leakey W. B. Patterson has a brush-and-stone dam across the Rio Frio 45 feet long and 2 feet high, built in 1896. This supplies a ditch 2 miles long, with a top width of 5 feet, a bottom width of 3 feet, and a depth of 3 feet. It was first used in 1897, and commands 300 acres, 125 of which have been cultivated. Near Riofrio, just across the line in Bandera County, is the Patterson ditch, owned by a company composed of three men. It was constructed in 1868, is 2 miles long, 5 feet wide, and of a depth varying from 3 to 4 feet. The dam is of brush and gravel, 30 feet long and 4 feet high. The soil is black and sandy, and under irrigation is very productive. In 1901 about 700 acres of

cotton, corn, oats, and garden truck were irrigated. The yields per acre were 1 bale of cotton, 45 bushels of corn, 20 bushels of wheat, and 75 bushels of oats.

Etheridge system.—At Montell, on the Upper Nueces, Mr. J. H. Etheridge is the owner and operator of the Casa Blanca Irrigation and Mill ditch, which was constructed in 1894; it is 2½ miles long, 6 feet wide, 7 feet deep for the first half mile, and from 2 to 3 feet deep for the next 2 miles. Water is taken from Nueces River by a dam of loose rock, which raises the water to the ditch. The dam is 300 feet long and from 2 to 3 feet high. The soil irrigated is rich alluvial, and corn yields 40 bushels and cotton three-fourths of a bale to the acre. During the season of 1901 this ditch irrigated 100 acres.

Landrum system.—The plant of William Landrum is near Laguna. The source of supply is five large springs, which have been forced into one by means of dams. The dams range in length from 30 to 100 feet and in height up to 6 feet. Some of them are of rock, others of clay. The water of the springs is forced into a ditch three-fourths of a mile long, 4 feet wide, and 2 feet deep, and is capable of irrigating more than 100 acres, although only 30 acres are usually irrigated. The system was constructed in 1894 and 1895.

KERR COUNTY.

In Kerr County, on the headwaters of Guadalupe River, there are a few small plants. That of Robert Tedford, near the post-office of Japonica, takes its water from Honey Creek by means of a loose-stone dam 15 feet long and 2 feet high. The ditch is 900 feet long, 1½ feet wide, and about 1 foot in depth, and irrigates 4 acres of tomatoes, onions, sweet potatoes, etc.

The plant of Silas Welch, near the post-office of Mountain Home, takes its water from a spring by means of a rock dam 40 feet long and 2½ feet high. The ditch, constructed in 1901, is 6,000 feet long, 3 feet wide, and about 1 foot deep, irrigating 8 acres of corn and garden truck.

Kaiser system.—W. C. Kaiser early in 1902 installed a pump plant a mile below Mountain Home, on the left bank of Johnson Fork. A 16-horsepower gasoline engine operating a centrifugal pump against a lift of 25 feet irrigates about 50 acres in the ordinary crops. This plant paid for itself in one season.

Thrailkill system.—W. F. Thrailkill, just below Mountain Home, irrigates 10 acres from Smith Branch, a tributary of Johnson Fork of the Guadalupe. A small plank dam 1 foot high deflects the water into the ditch.

KIMBLE AND EDWARDS COUNTIES.

Irrigation in Kimble County is chiefly confined to the valleys of the creeks tributary to Llano River and its two branches, the North Llano and the South Llano. This is due to the great violence of the river during high stages and the consequent difficulty of building dams and

maintaining ditches. Capt. C. K. Gordon's is the only plant that takes its water direct from the river. There are no "company" ditches in the county; in some instances two or three men have formed partnerships, but all the plants are small. Few of them water more than 20 or 25 acres, while the average number of acres watered is much smaller. There are thousands of acres lying along the river and its larger tributaries that might be irrigated if sufficient capital were employed to successfully dam the river and use the water on a large scale.

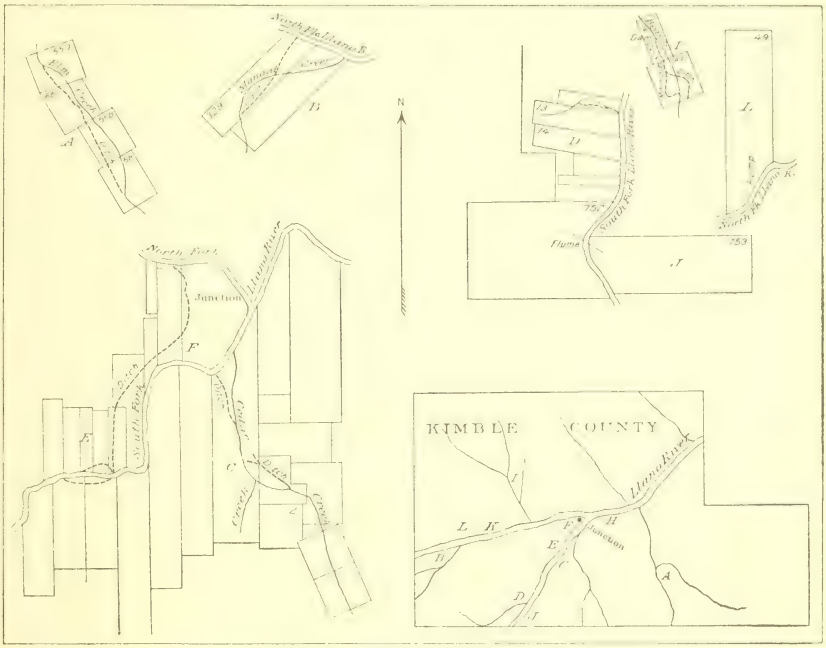


FIG. 14.—Map of Kimble County irrigation systems.

The following brief descriptions of the plants in Kimble County (see fig. 14) begin at the eastern end of the county and proceed westward. The plants are described in order downstream.

JOHNSON FORK OF LLANO RIVER.

The first stream on which there are irrigation plants is the Johnson Fork of the Llano, which joins the river about 5 miles below Junction City. There are four plants on this stream, as follows:

Moos system.—W. G. Moos's plant is three-fourths of a mile from the mouth of the Joy Branch, a small tributary of the Johnson Fork, about 11 miles above its mouth. It takes the water from the right bank of the Joy Branch, by means of an earth-stone-timber dam 60 feet long and 3 feet high. Thence the water is conducted along the right bank about 200 yards, and then is flumed to the left bank. The ditch is a fourth of a mile long, 1 foot deep, and flows at an average

depth of 1 foot. Eighteen acres are irrigated. The principal crop is corn, which produces about 30 bushels to the acre. Oats, wheat, cane, sweet potatoes, alfalfa, and garden vegetables are also grown. The yield of oats is about 40 bushels to the acre, and of wheat about 20 bushels. The cost of the dam was $25, of the ditch $25. The dam was first built by John Joy, prior to 1879.

Rembold system.—P. J. Rembold's plant is a little more than a half mile below the one just described, and is also on the Joy Branch. It was built by John Joy, prior to 1879. The dam is 60 feet long, of rock and gravel, and raises the water about 1 foot. The ditch is 300 yards long, 3 feet wide, and flows at a depth of 18 inches. Last year (1901) Mr. Rembold irrigated only 3 or 4 acres, but there are 67 acres of cultivated land within reach of the ditch. As many as 20 acres have been irrigated within recent years. Besides a garden the crop consists solely of Johnson grass. The cost of the dam was about $10, of the ditch $75.

Long system.—A. B. Long's plant is about 4 miles farther down the Johnson Fork. The water is raised 3½ feet by means of a 75-foot timber dam, consisting of upright timbers held in place by cedar posts and filled above with stones, gravel, and earth. Power is obtained by means of an undershot water wheel 8 feet in diameter and 5 feet long, operating two 6-inch force pumps of the walking-beam pattern, which raise the water 40 feet, through 100 feet of 5-inch iron pipe, to a flume. The flume conveys the water 100 feet, to a ditch 1½ feet wide, which carries it 600 feet farther, or to the field. Only 5 acres are irrigated, and only vegetables and fruits will be grown. It is interesting to note that an experiment is being made with strawberries. The cost of the dam was $50, of the flume and ditch $54, of the pipe $100, of the pumps $36, of the wheel $100, making a total of $340. The plant was constructed about 1898. This plant was recently sold to J. B. Bullard.

Owens system.—Eight miles from Junction City W. J. Owens operates a small pump plant, on the left bank of Johnson Fork of the Llano. A 12-horsepower steam engine operates a 3½-inch centrifugal pump against a small lift and irrigates a garden. This could easily be made to bring 200 acres under irrigation.

Armstrong system.—G. R. Armstrong's plant is on the Johnson Fork, about 3½ miles above its mouth. By means of a dam 86 feet long the water is raised 5½ feet. A race 86 chains long conducts it to a 15½-inch turbine, which operates a No. 4 submerged centrifugal pump. The pump raises the water 20 feet, at the rate of 600 gallons a minute (1⅓ second-feet). A reservoir 4½ feet deep, scraped out of the earth, and covering 1 acre, receives the water and distributes it to the field through a ditch a half mile long. Sixty-five acres of black loam are irrigated. The crop consists solely of alfalfa, which is grown for home use. The cost of the entire plant was $1,200.

CEDAR CREEK.

Cedar Creek, which flows into the South Llano about 1 mile southwest of Junction City, furnishes water for four plants, as follows:

Allen & Kelley systems.—J. A. Allen and W. H. Kelley own the first plant in partnership. It was constructed by J. H. Clements, and was completed in 1897. The ditch is three-fourths of a mile long, about 3 feet wide, and the water flows at an average depth of 10 inches. It takes water from one of the head springs of Cedar Creek, by means of a very simple dam of earth, logs, and stone. The dam is about 18 feet long and 2½ or 3 feet high. Immediately on leaving the dam the water is flumed across Cedar Creek, to the right bank, and soon branches. One of the branches is flumed across the creek, and after watering a small field is allowed to return to the creek. The other branch, at the point of separation, is flumed across a small draw, and after watering several small fields empties into the main ditch. Twenty acres of black soil are irrigated, usually planted in corn, oats, wheat, and cane. The yield of corn is about 40 bushels to the acre, of oats 60 bushels, and of wheat 23 bushels. The dam is about 5 miles above Junction City.

J. A. Allen and E. F. Kelley own the next plant, which is about a half mile below the one just described. This was the first dam built on the creek, being constructed about 1892. It is 60 feet long and is made of stone to a height of 4 feet. The ditch is three-fourths of a mile long and 3 feet wide, and carries a stream about 10 inches deep. The water is taken from the right bank of the creek about a half mile below the plant just described, waters a small field, is flumed across the creek and waters a second field, is again flumed to the right bank, and after watering a few acres is once more carried to the left bank and the remaining water is distributed through the largest of the fields belonging to the system. The large amount of fluming in this and the J. A. Allen and W. H. Kelley plant is made necessary by the sharp bends of the creek and by the precipitous bluffs. Thirty-three acres are irrigated, 8 acres belonging to Mr. Allen and 25 acres to Mr. Kelley. Corn and wheat are the chief crops.

Jarvis & Hodges system.—R. L. Jarvis and G. W. Hodges own the next plant, which is about 1½ miles downstream. The dam, which has just been replaced, consists of walnut-log pens securely bolted together and filled with stones. There are seven sections 10 feet long and two sections 8 feet long, all 6 feet wide. The upstream side is filled with gravel. The dam is 86 feet long and 4 feet high. The ditch is 80 chains long, 3 feet wide, and carries 6 inches of water. It emerges on the right bank of the stream and continues on that side. Forty-four acres are irrigated, 19 belonging to Jarvis, and lying nearest the dam, and 25 belonging to Hodges. The crops are corn, potatoes, wheat, and oats—chiefly corn, which yields about 40 bushels to the

acre. The cost of the dam was $40; the expense of maintaining is about $40 a year.

Taylor system.—W. W. Taylor's plant is just above the mouth of Cedar Creek. The dam is 60 feet long and 3 feet high, built log-pen style, and filled with stones and earth. The ditch is 2 miles long, 2½ feet wide, and carries 8 inches of water. It is on the left bank of Cedar Creek. It divides about 600 yards after leaving the creek, and one branch is flumed 75 yards, to the right side, where it waters the smaller field. Seven acres are irrigated. The crops are chiefly corn and potatoes. A garden is also watered. The cost of the dam was $25; the cost of the ditch, $300. The plant was constructed by Z. I., J. B., and J. A. Williams, about 1896.

BAILEY CREEK.

Jenson system.—On Bailey Creek, which flows into the South Llano about 10 miles above Junction City, is W. J. Jenson's plant. There is no dam, the water being taken direct from a spring on the left bank of the creek and carried in a flume across the creek and for about 350 yards along the left bank, where it divides. One branch is carried to a field on the right bank and the other across the creek again, in a 3½-inch iron pipe, and waters a field on the left bank. Only 4 or 5 acres are irrigated. Cane, corn, sweet potatoes, and garden vegetables are grown. The flume carries about 40 gallons a minute (one-tenth of a second-foot). The total cost of the plant was $100.

KYAC (CAJAC) CREEK.

Kyac (or Cajac) Creek, which flows into the South Llano from the left side, is the next stream that is used for irrigation. Four systems take water from this creek, as follows:

Dupuy system.—Maj. R. T. Dupuy's plant is about 2 miles from the mouth of the creek. There is no dam. The water is taken from a spring on the left bank of the creek, is flumed to the right bank, and is then carried by a 3-inch pipe to the field about 500 yards below. Seven acres are irrigated. The crops are oats and cane; a garden is also watered. The cost of the ditch was $30. The plant was constructed about 1883.

Griffith system.—S. A. Griffith's plant is about a half mile below the Dupuy plant. A lumber dam 50 feet long raises the water 2 feet. The ditch is a half mile long, 2 feet wide, and carries water to a depth of 6 inches. The water is taken from the right bank of the creek, but is soon flumed to the left bank, where it waters two small fields of 12 and 4 acres, respectively. The crops are chiefly wheat, corn, and vegetables. It is interesting to note that ribbon cane is successfully grown on a small scale. A yield of 200 gallons was raised from half an acre. This crop sells at 50 cents a gallon. The cost of the dam was $25; the

cost of the ditch $150. The plant was constructed by Q. Lowe in the eighties.

Bishop system.—J. L. Bishop's plant is a half mile below Griffith's. The dam is of stone, earth, and brush, 40 feet long and 18 inches high. The ditch is a half mile long, 2 feet wide, and carries a stream 6 inches in depth. The water is taken from the right bank of the creek. About 600 yards below the dam the ditch branches, one branch watering two fields near the point of separation, the other branch being flumed 106 feet across to the left bank, where it waters a third field. Fourteen acres of black loam are irrigated. The crops are sweet potatoes, corn, oats, millet, ribbon cane, and cotton. The noticeable feature about this plant is that 1½ acres were planted in cotton last year and one-fourth of an acre in ribbon cane, unusual crops in this county. The 1½ acres of cotton produced one bale; the yield of the cane was about the same as on Griffith's farm. The cost of the dam was $10; the cost of the ditch $150.

Calentine system.—F. L. Calentine's plant (on Mrs. Wooten's farm) is at the mouth of Kyac Creek. The dam, which is of logs, stone, and brush, is 80 feet long and 1½ feet high. The ditch is one-fourth of a mile long, 2½ feet wide, and carries a stream 5 inches deep. The water is taken from the right bank of the creek, is flumed 120 feet, to the left bank, and distributed to a field which lies along the South Llano. Twenty-five acres are irrigated, though 100 acres could with little trouble be put under the ditch. The chief crop is corn, 35 or 40 bushels of which were raised in 1900 on the irrigated land of this farm, while only 15 or 16 bushels were raised on the nonirrigated land. The cost of the dam was $5; the cost of the ditch $100. The system was constructed in the eighties.

FLEMMING BRANCH.

Flemming system.—O. B. Flemming's plant is on the Flemming Branch, a short distance above the confluence of that stream with the South Llano and about 15 miles above Junction City. His largest field lies along the Llano. The dam, which is of earth, logs, and stones, is 20 feet long and raises the water 1 foot. The ditch is a half mile long, 2 feet wide, and flows to an average depth of 6 inches. The water is taken from the right bank of the stream, is conveyed about 300 yards along the right bank, and then the ditch divides, one stream being flumed across to the left bank, where it waters a field of 5 acres, the other stream irrigating a field of 30 acres. The crops are corn, oats, cane, alfalfa, and a garden. The cost of the dam was trivial; the cost of the ditch was $75. The plant was constructed in 1890.

LITTLE PAINT CREEK.

Dougherty system.—The next plant in this vicinity is on what is known as the A. H. D. Dougherty place, at present (1902) occupied

by G. F. Wood. An earth-and-stone dam 50 feet long raises the water 1 foot. The ditch is three-fourths of a mile long, 2 feet wide, and carries a flow 6 inches deep. The water is taken from the east bank of Little Paint Creek, which flows into the South Llano from the left bank, about 1½ miles above its confluence with the South Llano. A large tank, constructed by throwing up embankments of earth, affords a storage reservoir 100 feet long, 20 feet wide, and 2½ feet deep. Twenty-five acres are irrigated. The chief crop has been corn, which yields 50 bushels to the acre. Twenty acres of cotton are to be planted in 1901. The cost of the dam was small; the cost of the ditch was $150.

SOUTH LLANO RIVER.

Baldwin system.—J. A. Baldwin has two small plants on the left bank of the South Llano, about 13 miles above Junction City. One of these plants makes use of a spring and has no dam and no ditch. A one-half-acre garden is irrigated. The other plant has a dam 10 feet long across a small spring branch which raises the water 1 foot. There are 100 yards of ditch 1 foot deep. Two acres of cane and corn are irrigated. The cost of the dam and ditch was trifling.

Hunger system.—T. Hunger has a small plant on the Ford Hollow Spring, a short distance from the South Llano and about 13 miles from Junction City. The water is taken directly from the spring, and is conveyed 1,150 feet, in a flume, to the garden irrigated. The flow is about 15 gallons a minute. A 1-acre garden is irrigated, from which Mr. Hunger derives a profit of about $250 a year. The flume cost $75. The plant was constructed in 1896.

Taylor system.—T. C. Taylor's plant is 17 miles above Junction City on the South Llano, though it does not take its water from the river. It is the last plant in Kimble County on the South Llano. The dam, which is of stone, is 5 or 6 feet long and raises the water about 10 inches. The water is taken from the Christmas Spring, on the left bank of the South Llano, and is carried under the river to the right bank in an iron pipe 300 feet long, and thence to the ditch through 1,326 feet of 8-inch sewer pipe. The ditch distributes it immediately to two fields of 14 and 11 acres, respectively. The principal crops grown are corn and cane, which are used at home for feed. The corn yields 40 bushels an acre. The cost of the dam was trivial; the cost of the iron pipe, $225; the sewer pipe, $331. The plant was constructed about 1892. Until the spring of 1901 Mr. Taylor used a flume instead of the 8-inch sewer pipe.

Barrett & Stephenson system.—C. C. Barrett and W. M. Stephenson own a plant about 2½ miles above Taylor's plant, just described, in Edwards County, about 2 miles across the Kimble County line. There is no dam, the water being taken directly from a number of beautiful springs which issue from the bluff on the left side of the South Llano. As a rule the bluff is too precipitous to permit the con-

struction of a ditch, hence the water is carried in a flume a large portion of the distance to the field, a tract of 25 acres about 1 mile down the river. The principal crops are corn, wheat, and cane. The cost of the flume and ditch was $200. It was constructed about 1895. This farm has only recently been purchased by Messrs. Barrett and Stephenson, and is generally known as the Black Place. The present owners intend to construct a new plant this summer (1901). They purpose to build a 4-foot dam across the Llano and use an 8-foot by 10-foot water wheel for power. This will operate an elevator pump to raise the water. Twenty-eight acres will be irrigated.

Huffman system.—One mile above Barrett's, on the South Llano, in Edwards County, is the plant of M. Huffman. There is no dam. The water is taken from a spring on the left bank of the river. The ditch is 300 yards long, 2 feet wide, and carries a stream 1 foot in depth. Seven acres are irrigated. Corn is the sole crop. The yield is 40 or 50 bushels to the acre. The cost of the ditch was $75. It was constructed by Henry Baldwin about 1895.

BEAR CREEK.

There are several plants on Bear Creek, a tributary of the South Llano, as follows:

Hall system.—The first plant in order coming down East Bear Creek belongs to Fred S. Hall. It is about 13½ miles above Junction City. The water is raised 4 feet by means of a timber dam, consisting of upright timbers held in place by cedar posts and filled with earth on the upper side. Below the dam the water falls on a cushion of cedar logs arranged parallel to the course of the stream. The ditch is a half mile long and 3 feet wide. The water flows about 9 inches deep, and irrigates a field of sandy loam containing about 9 acres. Last year (1900) the following crops were raised: Alfalfa and oats, 3 acres; garden, 1 acre; orchard, 2 acres; bermuda grass, 1½ acres; sweet potatoes, 2 acres. The sweet potatoes yielded 300 bushels to the acre, and were sold on the spot at 50 cents a bushel. The plant is now being enlarged and will be finished in time to irrigate the 1901 crop. About 800 yards below the dam is a branch ditch, which will be carried across the creek by means of 475 feet of 10-inch drain pipe laid under the creek. This will enable him to irrigate a field of 20 acres on the left side of the creek. The cost of the dam was $150; of the old ditch, $100, and of piping and new ditch, $150. The plant was constructed in 1895.

Reid system.—J. H. Reid's plant is on West Bear Creek, about 16 miles above Junction City. The water is raised 18 inches by means of a common earth dam about 25 feet long. It is then carried, at a depth of 4 inches, through a ditch 12 inches wide and a half mile long to a small field of 8 acres (in two patches). The crops raised in 1900 were corn, 2½ acres; sorghum, 2½ acres; potatoes, onions, etc. The

cost of the dam was probably not more than $5; of the ditch, about $50. The ditch is on the right bank of the stream.

D. L. Stewart system.—D. L. Stewart's dam is about 1 mile below Reid's. It was built in the eighties by John T. Mayes. It is 100 feet long and 3 feet high, and is made of earth and logs. The ditch is 1 mile long, 18 inches wide, and carries the water to a depth of 7 inches. The water is taken out of West Bear Creek, and is carried along the right bank for about 400 yards, when it is flumed across to the left bank. The field irrigated is mostly black loam, and contains 30 acres. The cost of the dam was $50; of the ditch, $150.

Morales system.—M. Morales's plant is on the left bank of West Bear Creek and is about 2 miles below that of D. L. Stewart. The dam is of stone and earth 150 feet long and 3 feet high. The ditch is about 2 feet wide and three-fourths of a mile long. This is one of the best as well as one of the most expensive ditches in Kimble County. Along part of its course it is walled with stone. Most of the remainder runs through a cut which averages about 5 feet in depth. The field irrigated contains 10 acres. The cost of the dam was $100; of the ditch, $175. The plant was constructed in 1899.

"L. C. pasture" system.—About a half mile below the Morales plant, and on the same stream, is the dam belonging to the "L. C. pasture," at present owned by G. D. Tarlton, of Hillsboro. It was constructed in the seventies, and is probably the oldest plant in the county. It is of earth, about 80 feet long and 2½ feet high. The ditch is 3 feet wide, a half mile long, and flows perhaps 800 gallons of water a minute (nearly 2 second-feet). It is carried along the left bank of the stream. The field of about 8 acres is used to raise alfalfa for the use of the ranch. A branch ditch also irrigates a small garden. The cost of the dam was about $30; of the ditch, about $40.

Alec. Stewart system.—Alec. Stewart's plant is just below the junction of East and West Bear creeks. It is 2 miles below F. S. Hall's and 1¼ miles below the "L. C. pasture" dam. The dam is similar to that of F. S. Hall, already described. It is 250 feet long and 3 feet high. The ditch is 1,000 yards long and 3 feet wide, and carries water to a depth of 12 inches. One hundred yards of the ditch is carried through a cut 4 feet deep. This is a new plant, having been constructed during the present spring (1901). The field irrigated, which contains 15 acres, is on the right bank of the creek. The cost of the dam was about $150; of the ditch, about $100.

Menge system.—William Menge's plant is on Walnut Creek, a tributary of West Bear Creek. It is about a half mile southwest of the dam of D. L. Stewart, and is a very small plant. The dam is 150 yards long and 12 inches wide, and flows about 50 gallons a minute. The field irrigated is a 1-acre truck patch.

Gordon system.—Capt. C. K. Gordon's plant is on the North Llano, 10 miles above Junction City. The water is lifted by means of a No.

7 centrifugal pump, operated by a 15-horsepower steam engine. The lift is 35 feet, 10 feet of which is by suction. Wood is used for fuel and costs practically nothing, as a quantity of driftwood is always on hand near the pump. The capacity of the pump with the present engine is 1,250 gallons a minute. There is no ditch. The water is discharged into a flume, by which it is carried 1,250 feet to the upper side of the field, crossing a road by means of an underground siphon. Between the road and the pump the flume is 20 inches by 12 inches, and is partially lined with zinc. Below the flume is 20 inches by 6 inches. No reservoir is used or needed. The plant is sufficiently large to irrigate 80 acres, but the field actually irrigated contains only 35 acres of black loam, with gravel subsoil. The crops raised are principally corn and alfalfa, which are used on the ranch. The average yield of corn is 50 bushels. The cost of the engine and pump was $800; of the house and appurtenances, $400; of the flume, $600; total cost, $1,800. The plant requires 1½ cords of driftwood to operate it one day. The wood is picked up near by. One engineer is required. A sawmill and a gristmill are also run by the engine.

Probable systems.—The flow of the South Llano at low ordinary stages is 90 second-feet near Junction City. A dam could be put in 10 miles above Junction City, and by bringing the ditch along the foot hills a mile west of the town and by taking it across the North Llano by a flume or inverted siphon 5,000 to 6,000 acres could be irrigated. In fact, the Ragsdale system did take out a ditch 4 miles above Junction City; but the dam was washed away some years ago, and it has never been rebuilt. It would also be possible to put in a system below the town by taking a ditch out on the north side of the main Llano. Any system put in will have to be very substantial, as the Llano is torrential at times.

SYSTEMS AT SAN ANTONIO AND VICINITY.

The irrigation ditches at San Antonio are historically the most interesting in the State, for here are found the oldest systems and structures, which have been in use more than a century. Additional interest is derived from the association of the ditches with the early missions and with the efforts of the Franciscan fathers to settle the Indians upon these lands and engage them in agriculture. These ditches traverse the city, often concealed by buildings and sidewalks.

MISSION AND NEIGHBORING DITCHES.

The original mission ditches, built by the Franciscan fathers between the years 1716 and 1744, are the Concepcion, the Alamo Madre, the San Jose, the San Juan, and the Espada, all dug to supply the lands belonging to the respective missions. In addition to these mission ditches, there was one, the San Pedro, which supplied water to the Villa Capital de la San Fernando, settled in 1730 by the

immigrants from the Canary Islands, and one built much later than any of the others, under the superintendence of the governor, Baron Ripperda, for the supply of the citizens of the town, and called the Upper Labor ditch.

UPPER LABOR DITCH.

Beginning at the head of San Antonio River, the most recent of the Spanish ditches—the Upper Labor—is the first encountered. It was begun in 1776, under the general direction of the royal governor, and was ready for use in 1778, care having been taken that there should be no infringement of the prior rights of the five missions and the Canary Island settlers. The ditch took its water from one of the large springs at the head of the river by means of a loose rock dam. It follows the contour of the land on the west side of the river and ends in San Pedro Creek. It once commanded about 600 acres, but is now out of use. In 1877 the city replaced the old loose rock dam by one of masonry, and built an extension to the ditch, called the Alazan branch. The latter was abandoned in 1896, because residences were built on the land irrigated.

ALAMO MADRE DITCH.

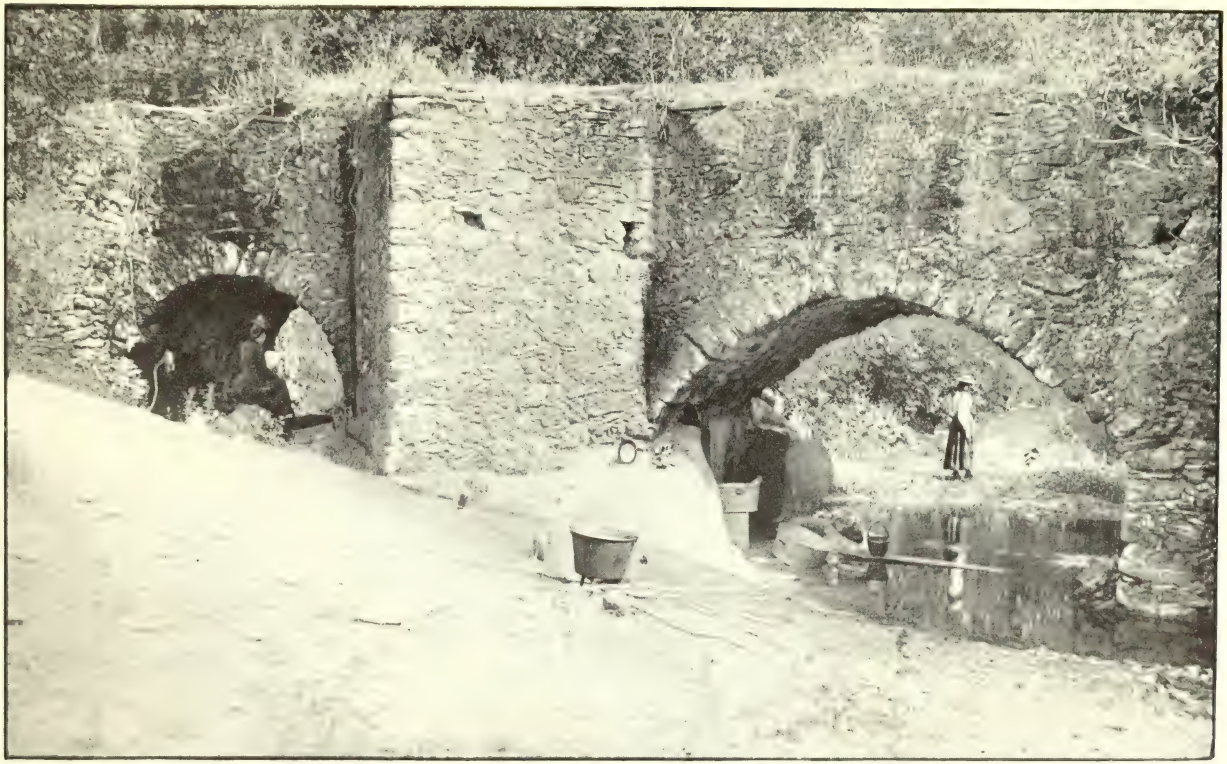
The Alamo Madre ditch, built between 1718 and 1744 to supply water to the Alamo Mission and irrigate its lands, derived water from the river on the east side just opposite the Upper Labor ditch, by means of a low dam. The ditch follows the contour of the land and runs through the business part of the city. Its length is 6 miles. It irrigated about 900 acres, but is now closed.

SAN PEDRO DITCH.

San Pedro ditch was commenced in 1738 and furnished water to the Villa de la San Fernando, the parish church of which, now called San Fernando Cathedral, is the geographic center of San Antonio. The water for the ditch, taken from the pool in San Pedro Park, follows the east side of the creek and runs through the center of the city, irrigating 500 acres of land below the town. Its length is about 4 miles, and it is 2 feet deep and 6 feet wide. The management of the foregoing ditches long since passed out of the hands of the landowners and into those of the city authorities and is now intrusted to a ditch commissioner appointed by the mayor. The annual water rent is $2 an acre.

CONCEPCION DITCH.

The next ditch of importance is the Concepcion, built in 1729 and abandoned in 1869, after being in use one hundred and forty years. It was discarded on account of the dam, which was in the center of the city, causing much damage from overflow when there was a rise in the river. This ditch was constructed to furnish water to the Mission de la Concepcion and was the largest of the old ditches.



OLD STONE AQUEDUCT CARRYING THE ESPADA DITCH ACROSS PIEDRAS CREEK.

SAN JOSE DITCH.

The San Jose ditch was built about 1720 to supply water to and irrigate the lands of the mission of that name, 5 miles below the town. The water was taken from the west side of San Antonio River, about 2 miles above the mission, and was returned to the river about 1 mile below. This ditch was abandoned about 1860.

SAN JUAN DITCH.

The San Juan ditch taps the river on the east side opposite the Mission San Jose. It follows the contour of the land and carries water down to the San Juan Mission. It was built in 1731 and is still in use. It irrigates more than 450 acres of land.

ESPADA DITCH.

The Espada is the lowest ditch taken from San Antonio River, though one of the oldest. The Spanish Government constructed it in 1824 and settled families on the land covered, assigning to each about 12 acres, known as suertes (swerties) and supposed to be the amount of land that could be irrigated from the ditch in one day. The ditch takes its water from the west side of the river, 6 miles below the city, by means of a loose rock-and-brush dam 270 feet long, built on a natural ledge of rock extending across the river, making the total height of the obstruction 8 feet. The dam consists of layers of brush weighted by loose rock, with gravel and earth thrown in front, forming a very effective dam, the rock becoming gradually cemented together by a deposit of lime salts from the water. It crosses Piedras Creek on a stone aqueduct, shown in Pl. VI, which consists of a series of massive arches that seem in as good preservation to-day as when constructed, more than a century and a half ago.

This ditch fell into disuse about twenty years ago and was abandoned until 1895, when A. Y. Walton, jr., who owned several suertes of land, organized the owners of the lands commanded by it into a company (the Espada Ditch Company), cleaned out, widened, and deepened the old ditch, repaired the dam, and made some change in its course, the total cost being about $3,000. The ditch is now 3 miles long, has a bottom width of 5 feet, and carries 10 second-feet of water. It commands 400 acres, nearly all of which is irrigated. The annual cost of keeping the ditch in good working order amounts to 25 cents an acre, the work being done by the members of the company. The manager notifies the members when work is to be done on the ditch, and no trouble has been encountered in repairing it on this labor-assessment principle. The general manager keeps a complete record of the hours and dates upon which each irrigator is to have water. Each member gets water every fifteen days, and is allowed all he wants, but he must use it only during the hours assigned to him.

The appearance of the crops under these ditches, even in a time of so abundant rainfall as the first half of 1897, is a remarkable proof of the value of irrigation. The land is mostly an alluvial valley soil, very productive when watered. On irrigated fields the customary yield is at least a bale of cotton to the acre, while for the last five years the average on unirrigated fields has been hardly more than one-fourth that amount. Truck farmers raise all kinds of vegetables from early spring until frost in the greatest profusion.

TRUEHART DITCH.

Three-fourths of a mile above the head of the dam which supplies the Espada ditch is the head gate of the Truehart ditch, which is now out of use.

ARTESIAN WELLS.

There is some irrigation from artesian wells practiced in and near San Antonio. Following are brief descriptions of the plants:

Kampman system.—The most extensive plant is that of Mrs. Caroline Kampman, who has three wells on her ranch, 3 miles east of the city limits. One of these wells has a flow of 1,500,000 gallons in twenty-four hours, under 20 pounds pressure, or 2.32 second-feet. It is 970 feet deep, and was drilled at a cost of $3,000. It is allowed to flow on 200 acres of the owner's land, most of which is in Johnson grass and sugar cane and needs only a small portion of the water. By a system of ditches or storage tanks this well would irrigate 1,000 acres of land. Almost all of the water from the other two wells is wasted. All of the water is impregnated with sulphur. Mrs. Kampman owns another well near the head of the river, 2½ miles northeast of the court-house, from which 26 acres are irrigated, but it could easily irrigate 300 acres.

Collins system.—Three miles west of San Antonio River, lying along the International and Great Northern Railroad, F. F. Collins has a farm of 140 acres which is irrigated from an artesian well 600 feet deep and 12 inches in diameter. The flow of this well has been estimated at 700 gallons a minute (1.5 second-feet). The water is clear and pure. The tract owned by Mr. Collins consists of 140 acres, all of which can be irrigated from this well. The farm is divided into tracts of 12½ acres each. A three-room house and the 12½ acres adjoining rent for $250 a year for land, house, and water. The latter is conveyed to the land by 4,000 feet of 6-inch pipe and 4,000 feet of 4-inch pipe. This method of conveyance guarantees a minimum loss by leakage and affords a most effectual control. The well is provided with two outlets, one of which supplies the pipe line on the farm, the other connecting to the reservoir. The reservoir is a triangular piece of ground covering 1 acre, one side of which is parallel to the track of the International and Great Northern Railroad. The capacity of the reservoir is 4,000,000 gallons, and the well fills it in seventy-two hours. It will be used to conserve the water supply, and will enable all irrigation

to be done in daylight. At night the flow will be shifted to the reservoir, and during the day water will be drawn from both the well and the reservoir.

Brady system.—The well of Thomas F. Brady is unique, in that it is deeper by several hundred feet than any wells in the vicinity. It is 6 inches in diameter and 1,450 feet deep. The water is soft and has the taste of rain water. It was noticed that the dry years affected it very slightly, but during the flush year of 1900 the water rose in the outflow conduit about one-fourth of an inch. Fifty acres of land are irrigated from the well, but it could easily irrigate as many more. Under present conditions the well is kept closed half of the time. The land is rented for $16 an acre, which includes the water rent.

Epp and Walters systems.—Just east of the Brady farm is the farm of John Epp, where a 4¼-inch well 884 feet deep irrigates 20 acres of forage, consisting mostly of cane and Johnson grass. Within a quarter of a mile of the Epp farm Mr. Albert Walters has a small well from which about 10 acres are irrigated.

Vandalle system.—About 2 miles west of the court-house, in the valley of Martinez Creek, Herman Vandalle has a 4-inch well 840 feet deep that irrigates 14 acres of garden truck. A small tank, 60 by 60 feet, has been constructed to conserve the flow and give a larger supply when necessary. The land rents for $25 an acre.

Koelblen system.—Near the Aransas Pass roundhouse Jacob Koelblen has a very successfully conducted irrigation plant from an artesian well. The well was bored in 1895. For the first 34 feet 10-inch piping was used. Into this was inserted an 8-inch pipe that extended to a depth of 200 feet, then 800 feet of 6-inch pipe was incased in this, and 1,027 feet of 4½-inch pipe completed the well to rock. The lower 70 feet was drilled into hard rock. A 4½-inch pipe leads from the well to a reservoir 72 feet by 30 feet, which borders on the east side of the San Pedro ditch, into which the waste water flows. The land irrigated lies on each side of the railroad track, the water being conveyed to it by pipes. Only 21 acres in garden are irrigated, but there is sufficient water to irrigate five times that amount. The water is rented out at $25 an acre. The drilling of the well cost $2 a foot, and the total cost of the plant, exclusive of land, was more than $4,000.

Dignowitty system.—A. F. Dignowitty owns two wells near San Antonio. The first well was bored in 1884, on the east side of Alazan Creek, 2½ miles northwest of the court-house. Water was struck at a depth of 160 feet, sulphur water at 210 feet. At 460 feet artesian water of 5 feet depth was struck, which shot 16 feet above the ground, giving a flow of 1,000,000 gallons per twenty-four hours. The water is clear and soft, of a temperature of 75° F., and is partly used for irrigation. The second well was bored in 1895. It is 1½ miles northeast of the court-house. At a depth of 20 feet a fine pottery clay 80 feet deep

was encountered; at 435 feet iron pyrites was met; and at 445 feet a vein of fine liquid asphaltum, which rose 45 feet in the well. At 456 feet a fine petroleum oil was struck; at 490 feet a substratum of clear fresh water, which rose to within 46 feet of the surface of the ground; at 500 feet a strong current of natural gas; at 525 feet a hard sandstone; at 540 feet a very hard white sandstone; at 550 feet another stream of water that rose within 35 feet of the top. The well stopped at 659 feet in hard, white rock.

SEWAGE FARM.

The sewage of the city of San Antonio is conducted about 4 miles southwest of the city and there utilized for irrigating purposes. Early in 1897 R. W. Hamilton & Co. made a contract with the city whereby the firm, in consideration of an annual payment of $1,000 to the city, was to receive all the sewage and the use of a tract of 350 acres of land. The company had to grub the land, erect houses, construct ditches, etc., before they could realize any income from their outlay.

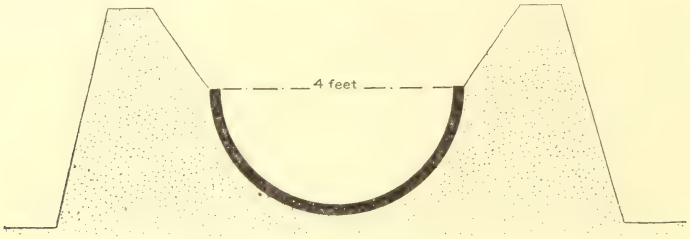


FIG. 15.—Cross section of sewer-farm ditch at San Antonio.

The sewage is delivered in the form of a half invert 44 inches in diameter, and to provide for an increased flow a dyke is constructed on each side of the invert, converting the whole into a canal the bottom of which is formed by the invert. (See fig. 15.) Three hundred and fifty acres are irrigated on what is known as the sewer farm proper, and the company has rented 150 acres from an adjoining farm, making in all 500 acres irrigated in 1901. In addition to this, about 3½ miles from the city the pipe line has been tapped and 50 acres are irrigated from the lateral. The flow is 10.8 second-feet, and 1,200 acres could readily be irrigated from it. At present the surplus is allowed to waste.

In September, 1901, the city leased the sewer farm and all of the sewage to R. H. Russel, J. A. Simmons, and others for a term of ninety-nine years. The lessees are to construct a ditch from the present outfall, a good and serviceable dam at Mitchells Lake, of a size sufficient to retain the surplus sewage of the city, and are to dispose of sewage by broad irrigation. They are also to guard the city against damages that may accrue from the sewage becoming a menace to private rights or a public nuisance. It is understood that the dam and ditch will

cost about $20,000. The lessees are to have the sole use of the sewage, and are to receive all rents from Hamilton & Co. for the two years their contract has to run.

MISCELLANEOUS SYSTEMS.

Halff Brothers system.—At the crossing of the river on Mitchell street, San Antonio, Halff Brothers have installed a 10-horsepower gasoline engine, which operates a rotary pump. The lift from the river level to the pump is 6 feet, and the water is pumped through 6-inch pipes alternately on the east and west sides of the stream. The capacity of the pump is estimated at 167 gallons a minute (0.35 second-foot). During the season of 1901 it irrigated about 20 acres, but had to be run only about one-tenth of the time. The crops raised were the usual garden truck, which found a ready home market.

Groos system.—Four miles below San Antonio, on the east side of the river, F. Groos has a pumping plant run by water power. It is on an old race, and consists of one 35-inch Leffel turbine operating two rotary pumps having 5-inch discharge openings and an estimated capacity of 400 gallons a minute each. The head on the turbines is 5½ feet, and it is estimated that 40 horsepower is generated. This will require a flow of 80 cubic feet of water per second. The San Antonio River has been known to flow only 10 cubic feet per second, and if all of this were utilized on the turbine it would generate only 5½ horsepower. The flow on December 31, 1901, was only 41 second-feet at the "hot wells," and in July, 1902, it was only 9 second-feet.

Praeger system.—Otto Praeger's plant, just north of the "hot wells," consists of a 10-horsepower gasoline engine and a double-suction rotary pump having 4-inch discharge. The water is raised into a flume, from which it flows into a ditch 600 feet long. Sixty acres of Johnson grass are irrigated. After a crop is cut and taken off, the water is immediately turned on until the ground is thoroughly saturated. Four weeks later the ground is flooded a second time, and two weeks later the grass is cut. Thus a crop is cut every six weeks. It requires 100,000 gallons of water per acre for a single saturation, and the plant waters one-half acre per hour.

Layton system.—Four and one half miles south of San Antonio is the Layton irrigation plant, which consists of a 15-horsepower Springfield engine operating a 6-inch Gould centrifugal pump. The lift is 17 feet and the estimated capacity 1,000 gallons a minute. The water is pumped from San Antonio River, and to deliver the quantity stated under the lift of 17 feet requires, with an efficiency of 80 per cent, only 4½ horsepower. Sixty acres of vegetables for the local markets are irrigated.

Brown system.—Five miles south of San Antonio, on the east side of the river, B. H. Brown irrigated 35 acres by means of a 5-horsepower engine operating a 4-inch pump. The water is pumped from San

Antonio River against a lift of 20 feet. The plant cost $400. The soil is black and very productive. Sugar cane, vegetables, corn, and oats are the crops raised.

Mission Farm Company system.—This company uses the natural outfall of the sewer and irrigates 50 acres of sorghum, Johnson grass, oats, and fruit trees.

Camille system.—The Camille plant, 4½ miles from San Antonio, pumps its water from the sewer outfall. The lift is 23 feet, and the pump has a discharge pipe of 4 inches diameter and a capacity of 900 gallons a minute. The soil is black. Eighty acres of vegetables are irrigated.

Meerscheidt system.—Near Prospect Hill, Meerscheidt Brothers irrigate 50 acres from a 12-inch artesian well. The water in the well rises to within 7 feet of the ground surface and is pumped into the ditches by means of a 12-horsepower Springfield engine and a 5-inch centrifugal pump. The capacity of the well is 750 minute-gallons, and this is sufficient to irrigate double the present acreage in dry seasons.

Pickett system.—Thirty miles below, on the same river, near Floresville, in Wilson County, is the plant of A. G. Pickett. It was set up in 1893, and consists of a 40-horsepower steam boiler operating a Blake duplex steam pump, which is connected to the boiler by a 2-inch steam pipe. From 12 to 15 horsepower is used at present, it being the intention of the owner to extend the plant, by the addition of more pumps, as more land is brought under irrigation. The average distance from the water to the pump is 15 feet and the average lift 50 feet. There is no reservoir, the water being pumped directly into the ditch. The total cost of the plant is estimated at $2,500, and it requires one man, at a cost of 12½ cents an hour, to operate it. The pump is covered by high water in the river from two to four times a year. This plant was built to irrigate from 300 to 400 acres, and has sufficient boiler capacity for that acreage, but will require additional pumps. The present pump has a 7-inch suction pipe and a 6-inch discharge, and is estimated to pump about 750 gallons a minute, or 1.67 second-feet, sufficient to irrigate from 75 to 100 acres, but only 50 acres of fruits were irrigated in 1901. The annual cost of water is estimated at from $2 to $6 an acre, according to the amount of rainfall and pumping.

State Agricultural and Mechanical College system.—The irrigation plant belonging to the experiment station of the State Agricultural and Mechanical College is a pumping plant deriving the necessary power from a windmill and a gasoline engine. The windmill is a steel Ideal, the original pump a deep-well pump having a maximum capacity of 80 cubic feet an hour. But this required a high wind to maintain the flow, and a 5½-horsepower (nominal) Weber & Co. gasoline engine, capable of exerting 4 actual horsepower was added. The pump has a cylinder 3½ inches in diameter by 36 inches long, with a

24-inch stroke when run by the engine and a 9-inch stroke when run by the windmill. The water is forced 600 feet to a reservoir 16 feet above the top of the well. The reservoir is 32 feet long, 52 feet wide, and 8 feet deep, and will hold about 100,000 gallons, 0.3 acre-foot. It was built by excavating to a depth of 4 feet and building around the excavation earthen walls of the same height, the total cost being $140. On account of the very porous nature of the soil all tanks in this region must be lined with artificial material—cement, asphalt, or coal tar. The reservoir at the experiment station is lined with a mastic consisting of 73 per cent sand, 25 per cent coal tar, and 2 per cent lime. The sand and lime are mixed together and the tar is boiled until it will string, when it is mixed hot with the other ingredients, and while hot is spread on the bottom and sides at the rate of 52 pounds to the square yard. On top is put a varnish formed by boiling pure coal tar and flashing it with a lighted match to burn off the light oils. The plant was completed in 1897, and it is estimated that 20 acres can be served by it. Gasoline costs 16 cents a gallon in Beeville, and 1 gallon used as fuel for the engine delivers about 1,900 gallons to the reservoir under the conditions stated. The cost of water per 1,000 gallons is 8.42 cents. Calculating the cost of a single irrigation at this rate, assuming that 2 acre-inches are supplied, 54,309 gallons (2 acre-inches) cost $4.58 per acre per application, or at the rate of $2.29 per acre-inch. Should land be permitted to become very dry before irrigation is resorted to the cost is increased correspondingly. Early in 1901 there was added to this plant a larger pump ($5\frac{3}{4}$-inch cylinder), the capacity of which is 70 gallons an hour. A new well has been sunk 12 feet from the old well, the two being connected 60 feet beneath the surface of the ground, so that the water of one well will supplement that of the other well.

McDowell system.—W. G. McDowell, of Beeville, has a plant consisting of a $1\frac{1}{2}$-horsepower gasoline engine pumping from a 70-foot well and irrigating 5 acres.

Beeville irrigated gardens.—These gardens have the most efficient plant near Beeville. It consists of a 4-horsepower gasoline engine pumping into a reservoir of 140,000 gallons capacity. Thirteen acres of vegetables are irrigated, but the plant could easily irrigate 20 acres.

Bee Star gardens.—The Bee Star gardens, of Skidmore, operate a plant consisting of an engine of 4 horsepower and an Ames pump with 4-inch suction pipe. The water is pumped from a $6\frac{1}{4}$-inch well 110 feet deep, and is discharged into a reservoir 120 feet in diameter, having a capacity of 500,000 gallons. Fifty acres of cauliflowers, cabbages, cantaloupes, etc., are irrigated. By judicious management of the water 100 acres could be irrigated.

Other truck systems.—The foregoing are types of many other systems in the country around and near Beeville. These plants generally consist of a small engine, a centrifugal pump, a surface reservoir,

and the necessary ditches. The following plants are in successful operation: S. A. McHenry (two plants), 27 acres; Carl Rankin, 12 acres; J. T. Holliday, 12 acres; J. K. Robertson, 7 acres; W. D. Messinger, 3 acres; A. M. Stoval, 12 acres; R. I. Eidson, 12 acres; J. H. Elliott, 4 acres, J. M. Chittim (near Normanna), 15 acres; James McCan (near Victoria), 25 acres.

Near Driscoll, in Nueces County, Charles Reynolds, George Reynolds, and Will Shealy are installing plants similar to the foregoing, while P. E. McNeill and John Clementson, at Wade's station, have each a plant in operation. The latter plants obtain the water from wells 150 and 190 feet deep, respectively, and during the current season 25 acres were irrigated.

King system.—On the King ranch, south of Alice, 46 artesian wells, of an average depth of 500 feet, furnish abundant water, and Mr. R. J. Kleberg, the manager, has commenced using this water for the irrigation of alfalfa; but this system is at present in its infancy.

Landa system.—Mr. H. Landa has just installed two irrigation plants on Comal River, at New Braunfels, for the purpose of irrigating about 70 acres of farm land. In one case the water is pumped from a lake near his flour mills and is forced through about 370 feet of 10-inch pipe into a canal in the field, being conducted through the canal to the highest point on the farm and then distributed by means of laterals to all parts of the tract. Intermediate laterals are also constructed at intervals along the main canal, and the water is carried by gravity to all minor elevations, the surface of the water in the main canal being higher than any point in the field. This system will water 25 or 30 acres. Mr. Landa's second system is supplied by a pump operated by a 20-horsepower gasoline engine, the water being elevated into a flume which leads into a canal that terminates on the bank of the river. This canal is constructed on the same principle as the one just described, the water being conducted to the highest portion of the field and distributed by means of laterals at intervals along its course. The tract to be irrigated by this canal contains about 40 acres. The canals are about 10 feet wide and the laterals 5 feet wide, constructed by building two parallel levees 10 feet apart, of sufficient thickness to prevent much seepage, the tops or crowns of the levees being made level, forming an elongated reservoir across the field, from which the water can be drawn at will. The total length of the main canal in the first system is 1,700 feet, the total length of the laterals 1,100 feet. The total length of the main canal in the second system is 2,200 feet, the total length of the laterals 2,700 feet. In the first case the water is raised 4 feet from the tank into the canal.

Locke system.—One mile west of New Braunfels Otto Locke irrigates 33 acres in orchards, nurseries, corn, potatoes, etc. A 12-horsepower Foos gasoline engine operates a 6-inch centrifugal pump against

a lift of 47 feet, raising 400 gallons per minute. The discharge pipe conveys the water to the highest point of the land, from which it is distributed by ditches to the lands watered. With the present prices of gasoline it costs $7 an acre per season. If continuously operated the plant could irrigate 50 acres.

Lenzen system.—The plant of G. P. Lenzen is located on the north bank of the Comal River in the suburbs of New Braunfels, and was first operated during the season of 1902. A 20-horsepower gasoline engine, operating a 6-inch Van Wie centrifugal pump against a lift of 60 feet, delivers the water into a 12 by 12 inch flume 500 feet long. Sixty acres in peas, sorghum, corn, cotton, and potatoes are irrigated at an average cost of $7 per acre.

Fischer system.—On the east side of the Guadalupe River, 1 mile below New Braunfels, near the bridge of the International and Great Northern Railroad, C. F. H. Fischer installed late in the season of 1902 a water-power irrigation plant. A dirt dam across the north channel of the Guadalupe deflects the water under a 7-foot undershot wheel, which operates a 3-inch Gould pump against a lift of 60 feet. The plant at present writing is an embryo of what is intended. A reservoir is to be constructed, and from this water is to be drawn to irrigate 50 acres in corn, cotton, grass, and gardens.

Bruemmen system.—One and one-fourth miles northeast of New Braunfels, W. Bruemmen uses an 8-horsepower Model gasoline engine to operate a centrifugal pump against a lift of 51 feet. The water is pumped out of the Guadalupe into a flume 1,100 feet long, which carries the water to the highest point of the 18 acres that are irrigated. The plant was put in late in the season of 1902, and its capacity has not been fully tested, but it has been found that it costs only $1.80 per day to operate the complete plant.

Starty system.—One mile north of New Braunfels, A. G. Starty has a small pump plant that derives its water from a well. A 6-horsepower gasoline engine runs a 4-inch Van Wie pump against a lift of 20 feet. The plant is located in the lowlands north of Landa Park, and during the current season 8 acres in cane, corn, and cotton were irrigated.

Dittmar system.—Five miles below New Braunfels, on the west side of Guadalupe River, Adolph Dittmar has a water-power irrigation plant. The water is pumped from the river by a Worthington pump having 10-inch discharge and a lift of 40 feet. The power is generated by one Risdon turbine working under a head of 5 feet. The dam is a natural formation in the river.

San Marcos Water Works Company system.—The San Marcos Water Works Company (William Green, president) transfers, by electricity, the power for its pump from a dam across San Marcos River, near the head of the stream. The distance from the water-power plant at the dam to the pump is 1,400 feet. The pump is a Van Wie centrifugal, having 18-inch discharge. The lift is only 8 feet, and it is the intention to bring 185 acres under irrigation.

Freeman systems.—About three-fourths mile below San Marcos, on the east side of the river, I. Freeman has a 16-horsepower gasoline engine which operates a 6-inch Morris centrifugal pump under a lift of 26 feet. The capacity is 1,312 gallons a minute, which would require only 8 horsepower. One hundred and twenty acres are to be brought under irrigation and cultivated in truck gardens.

J. R. Freeman has a 6-horsepower gasoline engine that runs a 4-inch Morris centrifugal pump, working under a lift of 26 feet. The estimated capacity is 350 gallons a minute. The plant cost $675. Ten acres of vegetables are irrigated.

Glover system.—The plant of Frank Glover consists of a 35-horsepower gasoline engine and a 12-inch Van Wie pump, operating against a lift of 35 feet. The water is pumped from San Marcos River, and it is intended to irrigate alfalfa and other crops. The soil is black and rich, and will produce well. The plant will irrigate 100 acres in 1902.

Lowman system.—Near the town of Staples, on San Marcos River, R. J. Lowman has a small irrigation plant in operation. The water is elevated to a height of about 21 feet, by means of an undershot water wheel carrying buckets on its circumference. The power is obtained from a 9-foot dam across the river. The capacity of the wheel is 300 gallons a minute. At present only 3 acres (a truck garden) are irrigated, and the wheel is not used to its full capacity.

Jones system.—About 5 miles below San Marcos, on San Marcos River, J. C. Jones irrigates a farm of 20 acres by means of the power obtained from a 7-foot milldam. He uses a 6-inch centrifugal pump having a capacity of 1,000 gallons a minute and one 2-inch rotary pump having a capacity of 125 gallons a minute. The water is lifted to a height of 31 feet. Part of it is pumped into a reservoir in the field, and the remainder is run directly from the pump to the field and there distributed. This is the first year the farm has been irrigated. The crop is to be corn and alfalfa. Cost of plant, $600.

Undershot water wheels.—Near San Marcos irrigation on a small scale is practiced by the use of undershot wheels, of wood, of the simplest form, with a metal bucket fastened to the perimeter of one side of the wheel in front of each paddle. These buckets fill in succession as the wheel turns and empty into a trough above, thus raising the water to a height of very nearly the diameter of the wheel. The wheel owned by Capt. John Richards irrigates 2 acres of grapes and vegetables, while that of D. C. Garret irrigates 7 acres.

SYSTEMS ALONG LOWER NUECES RIVER, LOWER RIO GRANDE, AND LEONA RIVER.

Nueces River rises in the Edwards Plateau and, with its tributaries, the Leona and the Frio, drains the portion of Texas between Brackett, San Antonio, Corpus Christi, Encinal, and Carrizo Springs. In this paper "the Lower Rio Grande" refers to the portion of that river

below Del Rio. The irrigation systems along the Nueces and its tributaries above the Southern Pacific Railroad are included in those of the Edwards Plateau.

LOWER NUECES RIVER.

Dolan system.—Going upstream, the first irrigation system is that of Pat Dolan, which is 6 miles below the crossing of the Southern Pacific Railroad. It consists of a 15-horsepower gasoline engine operating a pump, and with it he irrigates his garden and orchards. The cost of the plant was $735, and at the time of its erection gasoline was selling at 12 cents a gallon, and he says that irrigation under those circumstances could be made to pay.

COTULLA AND VICINITY.

Near Cotulla there are seven very effective pump-irrigation systems:

Copp system.—The plant of George Copp is the oldest, and originally cost $1,000. It consists of a 12-horsepower duplex steam engine and a 4-inch discharge pump, which, working against a lift of 45 feet, has an estimated capacity of 330 gallons a minute. The water is pumped from Nueces River and is delivered through 3,000 feet of pipe. The chief crop is Bermuda onions. It costs from $15 to $25 an acre to irrigate, depending upon the season. The yield is from 15,000 to 30,000 pounds an acre, and as the onions command from 1½ to 4 cents a pound the revenue is from $225 to $600 an acre. In all Mr. Copp irrigates 150 acres.

Butler system.—W. P. Butler's plant irrigates 10 acres by the use of a 4-horsepower gasoline engine and a centrifugal pump having a 3-inch discharge pipe. The water is pumped from Butler Lake and from Nueces River, and is raised 31 feet through 600 feet of delivery pipe. The system cost $700. The principal crop raised is Bermuda onions. The yield per acre and the price commanded are the same as in the case of Mr. Copp. Without rainfall the onions must be irrigated every fifteen days, while cabbages require water only once a month.

Kaley & Fuller system.—The plant of Kaley & Fuller consists of a 50-horsepower steam engine and a centrifugal pump having a 3-inch discharge. Water is pumped from Nueces River against a head of 26 feet. The estimated capacity is 600 gallons a minute, and 30 acres of Bermuda onions and cabbages are irrigated. The cost of the plant was $1,200. The yield and the revenue are the same as from the plants previously mentioned.

Uhl system.—The plant of Alexander Uhl cost $1,200, and consists of a 12-horsepower steam engine and a centrifugal pump having 6-inch discharge, operating against a lift of 28 feet. The capacity is estimated at 500 gallons a minute, and 35 acres of Bermuda onions are irrigated. The water is pumped from Harris Lake and from Nueces River, and is delivered through 1,150 feet of pipe.

Davis system.—The plant of J. H. Davis consists of a 12-horsepower steam engine and a duplex pump costing $1,000, and irrigates 100 acres of onions and tomatoes. The water is pumped from Nueces River, and is delivered through 2,000 feet of pipe. The capacity of the plant is estimated to be 200 gallons a minute.

Seafeldt system.—The plant of H. G. Seafeldt consists of a 15-horsepower steam engine and a duplex pump having a 4½-inch discharge, and irrigates 150 acres. Principal crop, Bermuda onions.

Hargus & Poole system.—The plant of Hargus & Poole consists of a 12-horsepower steam engine and a duplex pump having a 6-inch discharge. The plant cost $800. Water is pumped from Nueces River and is delivered through 500 feet of pipe.

UVALDE.

Kilgore system.—Six and a half miles west of Uvalde, on the left bank of Nueces River, is the plant of M. H. Kilgore and associates. A 55-horsepower engine operates a centrifugal pump, which delivers 1,500 gallons a minute (3⅓ second-feet) against a head of 73 feet. Wood is used as fuel, and as it is plentiful, the cost is nominal. The main ditch is 2 miles long, 6 feet wide at top, 2 feet at bottom; average depth, 2 feet. The plant was started in 1901, and 250 acres of the black, waxy, and sandy loam, most of it in alfalfa, were irrigated.

IDLEWILD.

Masterson system.—Near Idlewild, on the Southern Pacific Railroad, Branch T. Masterson has installed a pumping plant on Medina River. Steam is supplied from a 60-horsepower boiler, which operates the gin and mill, while the pump (8 and 12 by 12 by 10 inches) is connected direct. The head is 50 feet. The system was installed in the spring of 1901, and 200 acres, in oats and cotton, were irrigated. Medina River flows only about half of the year, but the plant is near a large pool in the river, which will furnish a supply at low stages.

CARRIZO SPRINGS AND VICINITY.

J. S. Taylor system.—Two miles below the iron bridge across Nueces River, on the road from Cotulla to Carrizo Springs, J. S. Taylor operates a pumping plant consisting of a 25-horsepower Buckeye engine, a 30-horsepower boiler, and an 8-inch centrifugal pump having 6-inch discharge. The lift is 25 feet, and 60 acres of onions, corn, and oats are irrigated. The water is pumped into a surface reservoir of about 2 acres area, located about 300 feet from the pump. The ditch leading from the reservoir to the field is one-fourth mile long. The pump is 100 yards above the dam mentioned below.

M. A. Taylor system.—On the ranch of M. A. Taylor a dam has been constructed across Nueces River about 2 miles below the iron bridge just referred to. The dam is 20 feet high in the center and 34 feet high on each side; wasteway 50 feet; length of dam about 170 feet. The dam is of live-oak log cribs filled with stones and backed

with stones, cement, gravel, and clay. The lake at low water is 20 feet deep and 5 miles long. To run the water out on gravity the dam would have to be built 29 feet high, which would give the water in the canal a total fall of 3 feet. The dam can be built 35 feet high, which would give a storage head of 9 feet, and would make a lake 10 miles long. The canal would be 1 mile in length and would turn the water out on gravity about 1 mile southeast of the ranch house. A storage dam 12 feet high and 200 feet long is to be constructed about three-fourths of a mile north of the soldier stone bridge, which would create a lake 10 feet deep and 10 miles long. To increase the height of the present dam to 29 feet in the center and 40 feet on each end, making it about 500 feet long, and to build the mile of canal 6 feet wide on bottom and with a slope of ½ to 1, would cost $6,000.

Artesian-well systems.—At Carrizo Springs artesian water can be obtained at a depth of about 100 feet. Artesian-well irrigation, however, is in its infancy. The wells 100 feet deep have a slow flow, although those of greater depth show a largely increased flow. The Paterson well is 590 feet deep and has a flow of about 200 gallons a minute, while the Campbell well, 5 inches in diameter, has a depth of 350 feet and a flow of 50 gallons a minute. These wells have not yet been used for irrigation, as they were completed late in 1901. Mr. Campbell has installed a 15-horsepower gasoline engine and a 5-inch centrifugal pump to augment his supply, and has constructed two earth tanks having a total area of 2 acres and an average depth of 8 feet. A well with a flow equal to the Patterson well could irrigate, under economical distribution, from 50 to 100 acres, depending on the season.

The Carrizo Springs.—No attempts have been made to utilize the flow of the famous Carrizo Springs for either power or irrigation.

LEONA RIVER.

The behavior of Leona River has been very irregular for several years. The Leona Spring, the source of its supply, is in the suburbs of Uvalde. It was dry in 1885, but soon revived and continued flowing until 1893, when it again stopped and has not flowed since. In 1893, before the spring ceased to flow, a pumping station for the city water supply was built on the banks near the spring, but a year or two after the spring failed, the pumping plant was transferred to its present location, within 150 yards of the court-house. At the new station a pit 15 feet by 15 feet by 24 feet deep was excavated, and the pumps were placed in its bottom. A well 4 feet by 7 feet was sunk in the bottom of the pit to a depth of 16 feet, or to the 49-foot level below the surface of the ground, from which water was pumped to a standpipe. At first the water rose in the well to within 35 feet of the surface, but in December, 1897, it was noticed that the supply was failing, and it continued to fail until May, 1898, when a second pit

10 feet by 10 feet by 9 feet deep was excavated on the southwest side of the first or main pit, and in it a well was sunk until its bottom was 63 feet below the surface. The pumps were then placed in the second pit, making their position about 33 feet below the surface. In January, 1899, however, the water level had fallen so low that it was necessary to bore in the pump well three wells of a depth of from 30 to 35 feet, reaching a total depth of 98 feet below the surface.

In June, 1899, after the heavy rains over southwestern Texas, known as the Brackett flood, the water was standing at about the 93-foot level and was slowly rising. On September 16, 1900, the water had risen to within 2 feet of the pumps, or to the 35-foot level. In other words, in fifteen months the water had risen about 58 feet, or nearly 4 feet a month. It continued to rise, and on December 1 had reached the pumps and arrangements were made to raise them. Accurate measurements during September, 1900, showed that the water was at that time rising in the wells at the rate of 4 inches a month.

Between the Leona Spring and the brickyard crossing, on the road from Uvalde to Pearsall, there are several small springs which contribute to the flow of the river, the largest being the Mulberry Spring. During the early part of 1900 this spring was flowing, but in September of that year its flow had ceased. On December 1, however, it had a flow of about 1 second-foot. In 1895 the discharge of Leona River at the brickyard crossing was 11 second-feet, but in June, 1899, the river was dry at the ford, and there was no water flowing between Uvalde and old Fort Inge, 4 miles below. On December 17, 1900, the flow at the brickyard crossing was 5 second-feet.

There are a number of irrigation systems along the river.

UPPER DITCH.

In 1874 a dam of dirt and logs was constructed across the river near old Fort Inge. It had a length of 53 feet and a height of 6 feet. The ditch known as the Upper ditch was taken out on the east side, the topography being such that a deep cut had to be made in the bank of the river. In all there are about 5 miles of ditches in this system, of the usual depth of 6 feet and of a width of 4 feet. Six hundred and thirty acres are irrigated from it. The crops raised are corn, hay, cotton, and onions. The yields per acre are 30 bushels of corn, 4 tons of hay, 1 bale of cotton, and 15,000 pounds of onions.

LOWER DITCH.

The Lower ditch was constructed in 1871. It is 4½ miles long, 6 feet wide, and generally about 3 feet deep. A dirt-and-log dam 50 feet long and 6 feet high forces the water into the ditch. The soil is a rich sandy loam. Three hundred acres are irrigated, the crops being corn, hay, and cotton. The yield is about the same as along the Upper ditch.

COMANCHE IRRIGATION COMPANY'S DITCH.

In Zavalla County, 2½ miles above Batesville, the Comanche Irrigation Company has taken out a ditch on the west side of Leona River. (See fig. 16.) It is 2½ miles long, 7 feet greatest depth, and 4 feet wide. The dam that deflects the water into the ditch is about 100 feet long and 15 feet high, and was first constructed in 1876, but had to be rebuilt. The ditch at first runs due west from the lake formed

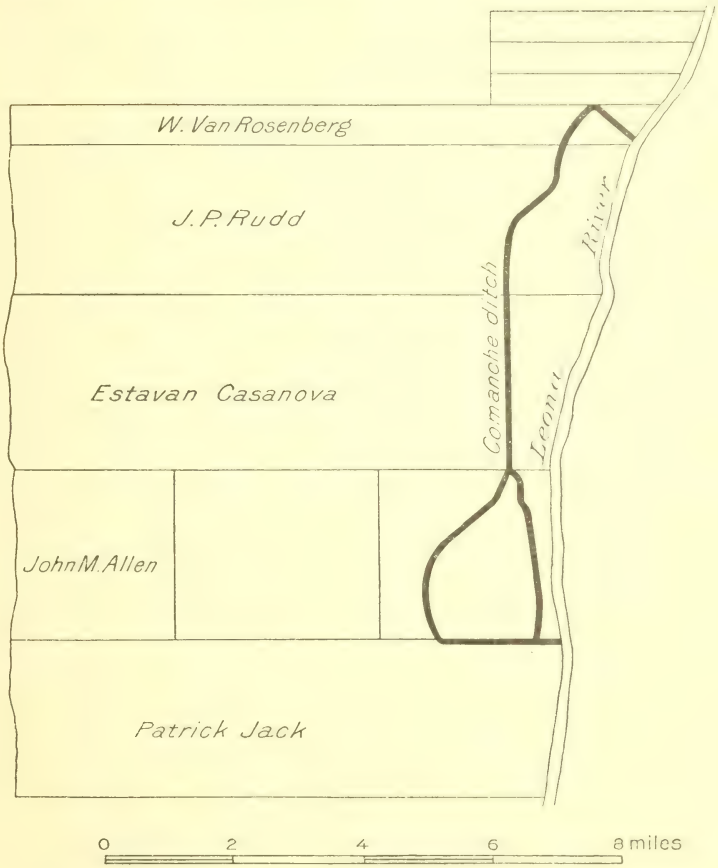


FIG. 16.- Map of Comanche Irrigation Company's ditch near Batesville.

by the dam for a distance of about 1 furlong, and then curves to the south, and for 2 miles runs almost parallel with the river, and then branches, in order to bring more land under it. The soil is a dark sandy loam of great depth, rich and easily cultivated, and is known as black mesquite. The company irrigates 500 acres of corn, oats, cane, hay, cotton, fruits, and garden truck. The corn yields 35 bushels and the cotton 1 bale to the acre.

LOWER RIO GRANDE.

The Rio Grande Valley forms one of the most inviting fields for irrigation on a large scale that can be found in Texas. At Brownsville the valley is 35 miles wide, decreasing slightly upstream toward Hidalgo. Five miles above Hidalgo the width suddenly decreases, and from there on it varies considerably, being at most a few miles and often almost nothing. There are from 180 to 200 square miles of rich and fertile valley land that could be brought into active production by clearing up the land, constructing canals, and installing pumping machinery. The minimum flow of the river at Laredo is 2,500 second-feet, and remembering that 1 cubic foot per second will irrigate and keep flooded 50 acres of rice, it can readily be seen that the natural factors of soil and water only await utilization to inaugurate a successful rice and sugar industry along the Rio Grande. Sytems have already been built near Eagle Pass, at North Laredo and Hidalgo, and at Brownsville and vicinity, as described on th following pages.

EAGLE PASS.

Dolch system.—Just below Eagle Pass L. F. Dolch has put in a large pumping plant with which he will irrigate 400 acres of the Rio Grande bottoms. His machinery consists of a 125-horsepower Frost engine and two 80-horsepower boilers, operating two centrifugal pumps of 14-inch discharge against a lift of 45 feet. The estimated capacity is 22 second-feet. The plant is on the banks of the river, the pumps being in a pit 31 feet deep and 20 feet in diameter. The water is drawn from the river through a 14-inch suction pipe 300 feet long, and is discharged through 1,100 feet of 14-inch discharge pipe.

NORTH LAREDO.

In North Laredo, on the banks of the Rio Grande, there are three pumping plants for irrigation.

Nye system.—The plant of F. C. Nye consists of two 60-horsepower boilers and a Quincy duplex pump having a capacity of 800 gallons a minute (1.8 second-feet) against a head of 65 feet. The water is pumped from a well on the sloping banks of the river. The well extends below the level of low water and is connected to the river by a pipe. It is well built, about 12 feet in diameter, and is lined with brick. The pump is on a platform in the well. Only 12 acres are irrigated, but 75 acres could easily be served. The pumps are usually operated eleven hours a day, at a cost of $7.50 for repairs, coal, engineer, etc. The fuel used is the Pecos coal, which costs $1.50 a ton. The land is watered twice a month, and the yield is 21,000 pounds of onions to the acre for unfertilized land and 31,000 pounds to the acre for fertilized land.

Lithgow system.—The plant of F. H. Lithgow is about a half mile

below the Nye plant, and consists of a 20-horsepower gasoline engine and an 8 by 10 Van Wie triplex pump, which has a capacity of 400 gallons a minute against a head of 70 feet. The water is delivered through a pipe 830 feet long. The cost, including oil, is $3.25 per day of eleven hours. The engine runs without supervision and can water 30 acres a day. The soil is alluvial, 10 feet deep, underlain with clay. The crops raised are onions, tomatoes, cabbages, carrots, turnips, watermelons, and cantaloupes. In all 38 acres are irrigated.

Madrigal system.—The plant of S. V. Madrigal, which adjoins the Lithgow plant, consists of a 10-horsepower Weber gasoline engine and a 6 by 8 triplex pump raising 200 gallons a minute against a lift of 70 feet. One acre a day is irrigated, and each section of land is watered every twelve to fifteen days. The pump is an upright direct-stroke and is operated by a belt from the engine. The suction pipe is a 4-inch, and the water is pumped from a well connected with the river similarly to that of the Nye plant. The well is 5 by 5 feet and is lined with timber.

HIDALGO.

Closner system.—At Hidalgo, down toward the mouth of the Rio Grande, is a steam pumping plant owned and operated by John Closner. It consists of a 50-horsepower engine operating a centrifugal pump having a capacity of 6.7 second-feet. The water is pumped from the Rio Grande, and 200 acres of sugar cane and corn are irrigated. The principal crop is sugar cane, which is manufactured into sugar that finds a ready market. This plant has proved one of the most successful in Texas, and it is paying an excellent return for the outlay.

BROWNSVILLE AND VICINITY.

Brulay system.—George Brulay, of Brownsville, has a pumping plant worthy of attention. Is is 8 miles below Brownsville, in Cameron County, and was completed and first used in 1896. It consists of two boilers, having an aggregate capacity of 100 horsepower, and a 45-horsepower Morris centrifugal pump, having a maximum capacity of 8,000 gallons a minute, or 17.82 second-feet. The total lift is 22 feet, and when in use the pump is run about fourteen hours a day. It is designed to cover 300 acres, but so far only 240 acres, planted in sugar cane, have been irrigated. A high-grade sugar is made from the cane juice.

Goodrich systems.—E. H. Goodrich reports having installed a 10-horsepower Priestman engine in a resaca on his place, 6 miles north of Brownsville, in March, 1897, but he has used it very little, owing to favorable weather and to the fact that the ditches are not yet finished. With two 12-foot windmills on the same place he can irrigate 35 acres. He also irrigates between 15 and 18 acres on his place, 3 miles north of Brownsville, by means of a 14-foot windmill pumping

from a well in the bank of a resaca. The distance to the water varies from 5 to 12 feet, and the pumps, which are three in number, discharge into a flume connected directly with the ditches. The total cost of the latter plant was $300.

Tijerina system.—Tomas Tijerina, Sabos Cavazas, and Pedro Cerna, on a farm about 9 miles above Brownsville, raise sugar cane by subirrigation from the Rio Grande. The cane is ground in an old-fashioned sugar-cane mill, and the juice is caught and boiled down to a consistency that will readily mold. The molds are of the form of a frustum of a cone of about 4 inches base. After the sugar is molded it is known as *piloncillo*. It is $\frac{98}{100}$ pure sugar, is hard, breaks readily, and the light varieties have a taste similar to that of maple sugar. The lumps are wrapped in the foliage of the cane and are put up in packages of 150 pounds, forming what is called a cargo, equal in volume to six American bushels. *Piloncillo* is one of the chief commodities of the Mexicans of the Lower Rio Grande.

COLORADO VALLEY SYSTEMS.

The irrigation systems in this section include those in the Colorado Basin which are within a short distance of the river or immediately upon it. The Edwards Plateau is drained on the north by the tributaries of the Colorado, but the irrigation systems on those tributaries are described in the Edwards Plateau group, pages 25 to 51.

STERLING COUNTY.

The first systems along the Colorado or its branches are in Sterling County, along the North Concho. There are two of them, one owned by the McGee Irrigation Company and the other by J. N. and J. H. Kellis.

McGee Irrigation Company system.—This plant is 5 miles from Sterling City. The main ditch is on the southwest side of the river. It is 2 miles long, has a top width of 6 feet, a bottom width of 4 feet, and carries about 1 foot of water. It was begun in 1892 and was first used in 1894. The water is raised by a loose-rock dam 125 feet long and 6 feet high, built across the river. The total cost was $1,500, and it commands 250 acres, only 70 of which are irrigated. The principal crops, in order of their importance, are cotton, corn, sorghum, oats, sweet potatoes, alfalfa, and vegetables. The ditch is kept in repair by each stockholder doing his share of the work.

Kellis system.—The Kellis plant was constructed in 1889 on the northeast side of the North Concho. The ditch is 1 mile long, top width 6 feet, bottom width 4 feet, depth 2 feet. The water is deflected into the ditch by a loose-rock dam 50 feet long and of an average height of 5 feet. The soil irrigated is a loose gray loam. Fifty acres are served from the ditch, the crops being cotton, corn, cane, oats, potatoes, and Johnson grass.

IRION COUNTY.

Near Sherwood, in Irion County, there are three dams across Spring Creek, the headwaters of Concho River. These are known as the upper, the middle, and the lower dam, and, although injured considerably by the floods of 1900 and 1901, each dam has its irrigation system in the chocolate-colored loam of the river valley. The upper and middle dams are 3 and 2 miles, respectively, above Sherwood. The ditches from them irrigate 266 and 216 acres. The lower, or Steinbaugh dam, is a half mile from Sherwood, and the ditch from its reservoir irrigates 153 acres. The crops raised command the highest market price, as competition is practically out of the question. The Sherwood system commands in all 635 acres.

TOM GREEN COUNTY.

In Tom Green County the irrigation facilities furnished by Concho River and its numerous branches and tributaries are among the best to be found anywhere in western Texas. These have been only partially utilized, however, in separate systems, by individuals and small companies, making the cost of maintenance much greater than if consolidated. Nevertheless they have been fairly successful, and have certainly reduced the cost of living in that section, making foodstuffs, especially vegetables, much cheaper and more abundant. Eleven plants are reported in the county—six on the South Concho, one on the North Concho, one on Lipan Creek, and one each on Spring Creek and Dove Creek. The location of all of these ditches, except the one on the North Concho (the Williams or Joe Glenn ditch) and the one on Lipan Creek (the Kelly ditch), is shown in fig. 17. The total area irrigated in the county is 3,500 acres.

Williams or Joe Glenn ditch.—The ditch of Mrs. W. D. Williams, known as the Joe Glenn ditch, is on the North Concho, 1½ miles west of Water Valley. It is 3 miles long, 8 feet wide on top, 4 feet wide on bottom, and 2½ feet deep. It was first used in 1886, and is supplied with water by a rock dam across the river, 100 feet long and of an average height of 8 feet. The total cost of the system was $3,500, and it commands 350 acres, 225 of which have been irrigated, two-thirds in cotton and the remainder in different sorghums and oats.

Glenmore farm ditch.—Two miles southeast of San Angelo is the celebrated Glenmore farm, sometimes known as the Cunningham farm, owned by A. F. Mabry. In 1891 a timber dam of the kind known as "turtle back," 74 feet long and of an average height of 7 feet, was built across the South Concho, and from it a ditch 4 miles long and of an average width of 6 feet and an average depth of 14 feet conducts the water to the land irrigated. The dam cost $4,000 and the ditch $500 a mile. The soil is a black sandy loam, and alfalfa, celery, cotton, and garden truck are produced in abundance. About 20 acres

are confined to a garden. The famous Glenmore celery is produced here. Ninety acres are irrigated, and the yield of alfalfa is 4 tons to the acre.

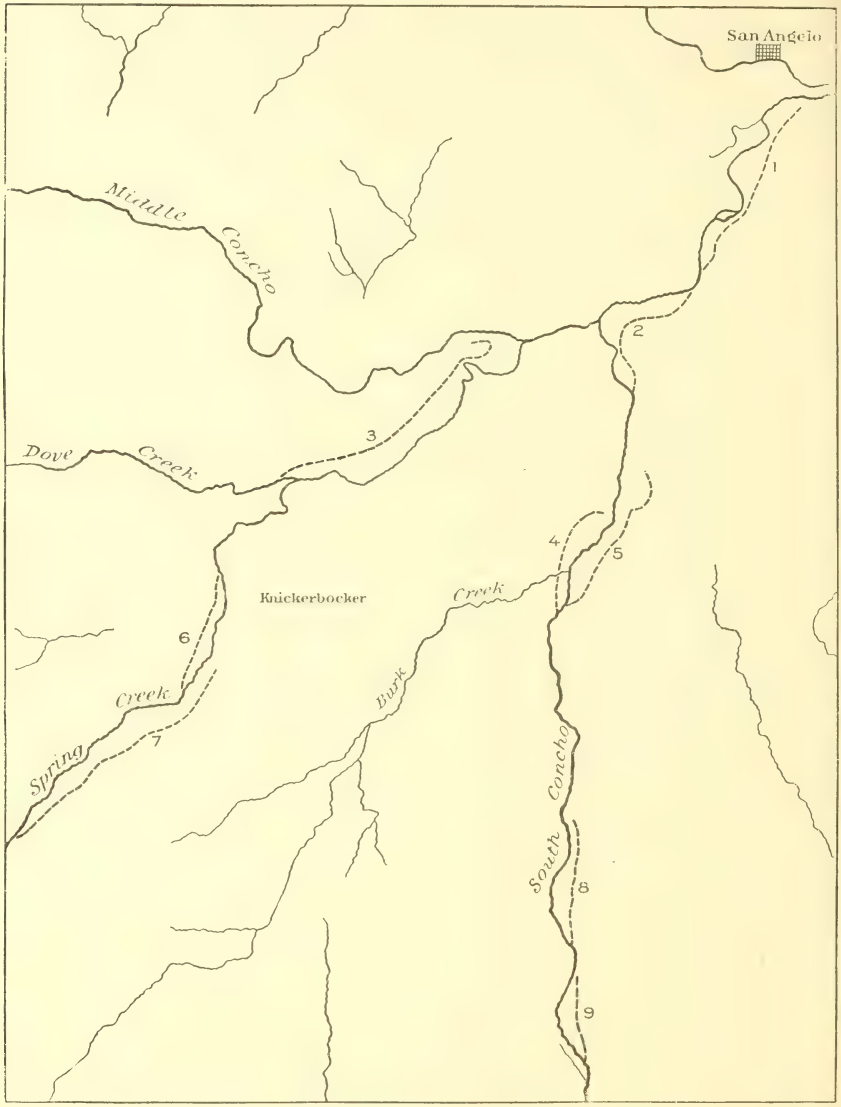


FIG. 17.—Map showing location of irrigation ditches in Tom Green County: 1, Cunningham ditch; 2, Bismarck ditch; 3, Twin Mountain ditch; 4, Gardner ditch; 5, Metcalf ditch; 6, Baze ditch; 7, San Jose ditch; 8, South Concho Irrigation Company ditch; 9, Miles ditch.

Bismarck ditch.—The Bismarck ditch, owned by Jones & Payne, of San Angelo, is 7 miles south of San Angelo, on the east side of the South Concho. It was projected by the Ben Ficklein Irrigation and Manufacturing Company, and was constructed in 1875. It is 4 miles

long, 10 feet wide, and of an average depth of 2.9 feet. A brush-and-rock dam 80 feet long and 10 feet high deflects the water into the ditch. The dam cost $1,500 and the ditch cost $900 a mile, the total cost being about $5,000. The soil is black loam; the crop raised oats, corn, cotton, sorghum, and Johnson grass. The yield per acre is 60 bushels of oats, 20 bushels of corn, two-thirds of a bale of cotton, and 3 tons of hay. Six hundred acres are irrigated. The most modern methods are used on this farm. The ground is plowed by use of a 20-horsepower traction engine, which, with three disk plows, breaks up 25 acres per day. Two crops are often raised on the same land in one year. When the small grain is cut, a crop of turnips is immediately planted, and these are off in time for small grain in the fall.

Gardner system.—The plant of A. F. Gardner is on the west side of the South Concho, 12 miles south of San Angelo. A dam of brush and rock 70 feet long and 6 feet high, costing $400, was constructed in 1883. It deflects the water into a ditch 2 miles long, 6 feet wide, and of an average depth of 16 inches. The ditch cost $250 a mile, making the total cost of the system $900. In all 70 acres of sandy loam are irrigated. The crops are oats, cotton, and Johnson grass, the yield being 60 bushels of oats, two-thirds of a bale of cotton, and 3 tons of grass to the acre.

Twin Mountain ditch.—The Twin Mountain ditch is on the north side of the river, at Spring Creek, 12 miles southwest of San Angelo. It is owned by Charles Mott, of San Angelo. A wooden dam 80 feet long and 7 feet high, built in 1885 at a cost of $2,000, deflects the water into the ditch, which is 3 miles long, 12 feet wide, and 15 inches deep, and cost $500 a mile. Under this system 300 acres of black loamy land are irrigated. The crops are oats, cotton, and Johnson grass, the yield the same as elsewhere in this locality.

Metcalf ditch.—The Metcalf ditch (owned by Metcalf & Sims) is 12 miles south of San Angelo, on the east side of the South Concho. It is 4 miles long, with an average top width of 12 feet, a bottom width of 8 feet, and a depth of water of 1½ feet. It was begun in 1887, and the first mile was completed the next year, but the ditch was not entirely completed until 1896. It takes water by means of a brush-and-stone dam 200 feet long and 7 feet high, which extends across the river. The cost of the dam was about $500, the cost of the main ditch $500 a mile, and the cost of the laterals, of which there are three, $250 a mile, making the total cost, with incidentals, $7 to each of the 470 acres now irrigated. The repairs, which are maintained by the tenants, may be estimated as amounting in labor to 75 cents an acre. The crops are Johnson grass, cotton, corn, oats, wheat, and garden truck.

South Concho Irrigation Company ditch.—The plant of the South Concho Irrigation Company was constructed in 1881. It is on the east side of the river, 20 miles south of San Angelo. The brush-and-

rock dam is 70 feet long and 7 feet high, and cost about $600. The ditch is 3 miles long, 7 feet wide, and averages 16 inches in depth. It cost $400 a mile. The soil is rich, black loam, and the 220 acres irrigated yield 60 bushels of oats and 3 tons of Johnson grass per acre.

San Jose Irrigation Company ditch.—The dam of the San Jose Irrigation Company (of which Joseph Tweedy, of Knickerbocker, Tex., is the secretary) is on Dove Creek, about 8 miles from Knickerbocker. It is composed of brush, rock, and gravel; is 900 feet long and 8 feet high, and cost about $1,250. The annual repairs cost from $50 to $100. The dam deflects the water into the ditch, which is 6 miles long, 8 feet wide, and 1½ feet deep, and cost about $300 a mile. The soil is chocolate-colored loam, and 1,400 acres are usually irrigated. The crops are oats, corn, cotton, sorghum, and Johnson grass, the annual yield per acre being 40 bushels of oats, 20 bushels of corn, three-fourths of a bale of cotton, and 3 tons of hay. This is by far the largest irrigation system in the Colorado Valley.

Baze irrigating ditch.—Five miles below the dam of the San Jose Company and 3 miles from Knickerbocker is the dam which feeds the Baze irrigating ditch. This was constructed in 1875 and is now owned by Dr. Boyd Cornick and others. It is of wood and rock, 48 feet long, and 8 feet high, and cost about $500. The ditch is on the west side of the creek. It is 3 miles long, 7 feet wide, and 1½ feet deep. The soil is similar to that of the San Jose Company's tract. One hundred and sixty acres of oats, alfalfa, and cotton are irrigated.

Kelley system.—Twenty miles southwest of San Angelo, on Lepan Creek, is the system of Mr. W. S. Kelley. In 1894 he constructed a wooden dam 40 feet long and 4 feet high, which feeds the ditch. The latter is 1½ miles long, 4 feet wide, and about 1 foot deep. The soil is a sandy loam. Forty acres of oats, Johnson grass, and garden truck are irrigated. The dam cost about $150 and the ditch $175 a mile.

BROWN COUNTY.

Swinden Pecan Orchard Company.—Near Brownwood, in Brown County, about 120 miles east of San Angelo, there is a large area suitably located for irrigation on an extensive scale. In it is the plant of the Swinden Pecan Orchard Company, which consists of a centrifugal pump operated by an 80-horsepower engine, pumping 3,000 gallons a minute, or 6.84 second-feet. The water is carried by a flume 4,000 feet long to a reservoir formed by an earthern dam 400 feet long and of a height varying from 2 to 15 feet. The dam is at the foot of gently sloping land, and forms a triangular reservoir covering 55 acres. The reservoir is designed to irrigate the 400 acres of level land lying along the Pecan Bayou, from which the water is pumped to fill it. A small stream is also dammed and turned into the reservoir. The 400 acres commanded by the reservoir are planted in pecan trees, making the largest orchard of that kind in the world. The irrigation plant was put in chiefly to enable the owners to practice

truck farming and the growth of small fruits between the rows of trees while waiting for the latter to mature. The soil is a rich black and chocolate colored loam. A great mistake was originally made in having the reservoir so large and shallow. Evaporation and seepage were in this way increased. To reduce the loss by evaporation an inside dam has been constructed, decreasing the area of the reservoir.

Fairland irrigated farm.—The Fairland irrigated farm, owned by J. F. Smith and brother, is a short distance from Brownwood. Two pumping plants have been installed. The first one consists of an Ivens single-suction centrifugal pump, operated by a 50-horsepower Chandler & Taylor plain slide-valve engine. With an average lift of 15 feet 4,000 gallons a minute (9 second-feet) can be discharged through the 10-inch discharge pipe. The second plant consists of an Ivens double suction pump having a 13-inch discharge pipe, and driven by an 80-horsepower Nagle engine, which delivers 5,000 gallons a minute (11 second-feet) against a head of 30 feet. The length of the ditches is about 4 miles, the width 6 feet at top and 3 feet at bottom, and the depth 1 foot. There are 400 acres under ditch, and 1½ bales of cotton per acre are produced from irrigated land, while only one-fourth bale can be produced from unirrigated land. The first plant cost $2,000, the second plant $3,000, making a total of $5,000. In 1900 high water destroyed the crop.

MILLS COUNTY.

In Mills County several pumping plants were formerly operated along Colorado River, but the high water in June, 1899, and in April, 1900, damaged them by either submerging the pumps or destroying ditches and crops to such an extent that some of the owners were discouraged and never repaired the plants.

LAMPASAS COUNTY.

Finlan system.—One mile east of Lampasas Mrs. Owen Finlan for years operated a windmill plant, the water being pumped into a cement tank 60 feet in diameter. In 1901 a 4-horsepower gasoline engine was added. This plant is on the south bank of the Sulphur Fork of Lampasas River, and pumps the water from the pond or lake formed by Donovan's dam. The water is raised 20 feet by a bucket pump, and is delivered into a flume which conveys it to the cement tank. From the tank the water is conveyed to the land through a system of ditches. Fifteen acres of truck gardens are successfully irrigated. The yield of onions and sweet potatoes is exceptionally large. Below the plant of Mrs. Finlan there is a fertile valley that could easily be brought under ditch.

TRAVIS COUNTY.

Near Del Valle, in Travis County, there are two pump plants. That of George Begg consists of a 60-horsepower engine, which operates a 10-inch centrifugal pump against a lift of 45 feet; 200 acres in

ordinary crops will be irrigated. The plant of N. H. Shappard consists of a 12-horsepower engine operating a 6-inch centrifugal pump against a lift of 40 feet. Only 20 acres were irrigated this season (1902), but plans have been formed to enlarge the system by adding a 45-horsepower boiler and two 10-inch centrifugal pumps.

SYSTEMS NORTH OF COLORADO RIVER.

Irrigation in this region is rare, for two reasons: (1) The section (the eastern portion) where the streams would furnish water for irrigation has sufficient rainfall to raise crops unaided; and (2) the western portion, including the Staked Plains, has no streams available for irrigation, the underground waters are still undeveloped, and the construction of impounding reservoirs has commended itself neither to private enterprise nor to public favor.

BELL COUNTY.

Hoover system—One mile west of Killeen, in Bell County, A. J. Hoover has shown what could be done by windmill irrigation. His plant consists of a Dandy windmill, 13 feet in diameter. The water is pumped from a pool 100 feet from the windmill, and is forced through 300 feet of 3-inch pipe into an earthen tank 50 by 100 feet, along the track of the Gulf, Colorado and Santa Fe Railroad. The water is elevated 14 feet. Five and a half acres of garden are irrigated. A ready market is found for all vegetables raised.

BURNET COUNTY.

There are three small systems in Burnet County, two from springs and one from the Colorado River. The latter receives its water from the dam of the Tanner Brothers, at Bluffton, and 30 acres are irrigated from this plant. Ten miles west of Burnet, Mr. Williams irrigates 15 acres in a truck garden, the water being obtained from a spring. A similar plant is located 10 miles south, at Marble Falls.

WILLIAMSON COUNTY.

There are a few small patches irrigated in the western and central part, but these consist of only a few acres. Early in 1902 H. T. Sterns installed a pumping plant 5 miles north of Taylor to irrigate ordinary crops. The water is derived from San Gabriel River by means of a 13-horsepower Charter gasoline engine operating a 3-inch Van Wie centrifugal pump. The dry-land corn around Taylor was burned up by the drought of 1902, and, as in the other central portion of Texas, it was cut for fodder. However, the irrigated corn of Mr. Stern afforded a severe contrast to the dry-land corn of his neighbors; while theirs was virtually burned up, his was as abundant as that grown on the best black land. The soil irrigated here is in the black waxy strip, which is known as the richest lands in Texas.

The few small systems referred to above are located along the San Gabriel and derive their water from springs. The plant of H. E. Townes is 8 miles west of Georgetown, and he irrigates 15 acres in tomatoes, sweet potatoes, beans, etc., from the old Knight spring. John Ischy, 4 miles west of Georgetown, irrigates a truck garden of 7 acres from the old Harper spring; while the plant of W. H. Donathan, 3 miles west of Georgetown, on the Middle Gabriel, irrigates his truck farm from a spring, in two levels, the lowest being irrigated from the ditches that lead from the spring, and the upper by means of a windmill that raises the water 3½ feet.

MILAM COUNTY.

Near Cameron, Milam County, five pumping plants were installed somewhat late in the season of 1902. Four of these take their water from Little River and the other from a spring. The plant of McLane & Crain is 2 miles southwest of Cameron, on the southeast bank of Little River, and consists of a 100-horsepower boiler, a 75-horsepower engine, and an 8-inch Van Wie pump working against a lift of 27 feet. The farm consists of the rich black shell bottom lands, with an admixture of sand near the river banks. The San Antonio and Aransas Pass Railway passes through this farm on a high trestlework. The cotton and corn had just been watered when the August floods completely submerged a large part of the crop, killing corn and cotton and making the season's work a complete loss. The plant of J. M. Crain consists of a 10-horsepower engine and a 3-inch centrifugal pump working against a lift of 26 feet. However, no results were obtained, on account of the overflow mentioned above. The island farm of John B. McLane lies almost south of Cameron, on the south side of Little River, and its topography is such that the ditches have a good fall as they leave the river bank. A levee along the river bank above the pumping plant should be constructed to protect the lands from destructive overflows of the river. The present plant consists of a 20-horsepower engine which operates a 5-inch Van Wie centrifugal pump against a lift of 27 feet. There are 175 acres in the farm, and it is intended to add heavier machinery in order to increase the acreage. Just west of the city waterworks plant, on the north bank of the river, L. F. Blanchard has an irrigated truck garden of 20 acres. The water is obtained from the river by means of a 15-horsepower stationary steam engine which operates a 4-inch centrifugal pump. The land is very rich, and two crops are readily raised each season. The 6-acre truck garden of S. J. Brooks is a mile west of Cameron, and is irrigated from a reservoir directly. The water from a spring is piped to a fish pond, from which it is pumped into the ditches. The plant consists of a 2.5-horsepower Weber gasoline engine which operates a 2-inch rotary pump against a lift of 6 feet. The land irrigated was formerly an old quagmire.

STAKED PLAINS.

The Staked Plains is a great plateau, about 36,000 square miles in extent, with an almost flat surface which gradually rises from an elevation of 3,000 feet to 4,500 feet above sea level. Flowing water, except from a few springs, is almost unknown. The soil is of such a character that it readily absorbs the rain that falls upon it, which percolates downward and is reached in wells from 40 to 200 feet in depth. Many of these wells are capable of furnishing a supply almost inexhaustible to ordinary means of pumping. The soil is often too dry to be successfully cultivated without irrigation, which can be practiced only by means of water raised by pumps. Pumping, however, is most easily accomplished by means of windmills, which are remarkably successful in this region, owing to the almost constant winds which sweep across the plains. Windmills have been used for many years to furnish water for stock, and they have been tried successfully on a small scale for irrigation. The settlers of the plains have learned to appreciate the value of devices of this character for raising water. Reservoirs or tanks are almost always used in connection with the mills. The sides and bottoms of these are made impervious by turning in a little water and puddling the soil by driving horses or cattle about in it for a day or more.

Morrison system.—About the center of the Llano Estacado or Staked Plains, in Hale County, T. W. Morrison owns a plant consisting of two Aermotors, 8 and 12 feet in diameter, respectively, pumping from wells 50 feet deep, with water 20 feet below the surface. Each windmill lifts the water 35 feet. One wheel is used for supplying the residence; the other pumps into a reservoir 125 feet long, 100 feet wide, and 4 feet deep, and irrigates 10 acres, besides furnishing water for the stock. These wheels have been in use since 1891.

Wayland and Herbert systems.—J. H. Wayland, of the same county, has three Aermotors pumping from wells 35 to 60 feet deep into a reservoir 300 feet long, 75 feet wide, and 6 feet deep, irrigating 10 acres in 1901. The total cost of wells, pumps, wheels, and reservoir was $505. The total cost of the plant, which must include land and fencing, is given as $1,000. W. P. Herbert also irrigates 5 acres, and C. E. McClelland states that there are at least 50 families in Hale County prepared to irrigate by windmills from 5 to 20 acres if the season renders irrigation necessary, but for the last two years the seasons have been so good that irrigation has not been practiced.

SYSTEMS NORTH OF TEXAS PACIFIC RAILROAD.

There are hundreds of windmill plants north of the Texas Pacific Railroad. In the counties of Haskell, Shackelford, and Young, in fact in nearly all the counties east of the one hundred and first merid-

ian, there are small garden patches, varying in size from one-sixth to three-fourths of an acre, irrigated by windmills. Fifty replies to letters sent out by the writer have not shown, with the exception referred to in these notes, a windmill plant that irrigated more than a half acre. Two windmill plants of Haskell County (those of W. H. Parsons and H. H. Nesbett) are typical of them all.

Parsons and Nesbett systems.—The plant of W. H. Parsons consists of a Dandy windmill 4 feet in diameter, pumping from a well and irrigating 1 acre. The plant of H. H. Nesbett consists of an Aermotor 10 feet in diameter and a 4-foot well 38 feet deep; depth to water, 31 feet. This wheel irrigates 3 acres of black, sandy soil.

Reynolds Land and Cattle Company.—The Reynolds Land and Cattle Company, near Channing, Hartley County, irrigates 40 acres from a spring. The principal crop raised is alfalfa, but a small orchard of fruit trees and a garden are also irrigated. The orchard consists of apples, peaches, pears, plums, and grapes. The underground water supply in the neighborhood of this ranch has not proved sufficient to irrigate more than small gardens.

Rathjen system.—F. H. Rathjen, of Mobeetie, Wheeler County, irrigates 60 acres of corn and alfalfa, from Williams Creek, which is fed by springs. The creek is 5 miles long and there is sufficient water to feed the quarter-mile ditch. The soil irrigated is a red loam.

Kempner & Lasker system.—Messrs. Kempner & Lasker have constructed a dam across Holiday Creek, about 5½ miles south and 20 degrees west of Wichita Falls. It is of earth, 3,000 feet long, 35 feet high in the creek, 25 feet high for 1,100 feet, and about 9 feet high at the north end. There are two wings, one 5,100 feet long and the other about 700 feet long, making a total length of 8,800 feet, or 1⅔ miles, and containing 150,000 cubic yards of material. The watershed is estimated to be 150 square miles. The creek is generally dry, but sometimes has a large flood volume passing down to Wichita River. The reservoir formed has a capacity of 13,000 acre-feet and covers 2,050 acres. It is estimated that it will irrigate from 4,000 to 8,000 acres. Part of this dam was washed away in May, 1901, but it is stated that it can easily be repaired.

LIMESTONE AND COMANCHE COUNTIES.

Stubenrauch system.—At Mexia, in Limestone County, J. Stubenrauch has been very successful in the use of a small irrigation plant for fruits and vegetables. The plant consists of a dam across a ravine, catching the storm waters and forming a tank covering about an acre of ground. From this the water is lifted to a height of 25 feet, by an 8-foot windmill, into an earthen reservoir 50 feet long and 100 feet wide. The reservoir is now being enlarged, to have double its present capacity. The total cost of the system was $300, including 700 feet

of piping. Seven acres have been irrigated, but it is estimated that 15 acres could be watered. Mr. Stubenrauch has put in another system, with a reservoir covering an acre of ground, the dam having a height of 5 feet above the outlet pipe. For filling the reservoir he uses a 12-foot wheel. He pumps from a storage tank made by damming a ravine. The dam on top is fully 10 feet wide, and both the reservoir and the storage tank hold water like a jug. The total cost, including 600 feet of 2½-inch pipe for discharging water into the reservoir, was $485.

Mr. Stubenrauch says:

For the gardener or fruit farmer there is no investment bringing in larger returns than an irrigation plant similar to what we have here. In the very driest season 300 bushels of sweet potatoes to the acre are easily grown, which can be disposed of during August and September at one's own prices. In 1899 there were grown some of the finest cauliflowers ever produced. Dozens of heads weighed over 6 pounds each. Have irrigated fruit only the past season (1900). Five acres irrigated as a truck farm near a good market are worth more to the owner than are 75 acres without, of similar land for the same purpose.

Lee system.—One and one-half miles from the town of Comanche W. T. Lee irrigates 5 acres from an 8-inch well 95 feet deep. The water is pumped by a windmill into a circular reservoir 100 feet in diameter and 6 feet deep. This reservoir was formed on a knoll, by scraping the earth from the central space into the leveed embankments. From the reservoir the water is conducted in different directions by 3-inch pipes and by ditches. The crops raised are chiefly garden vegetables and such fruits as pears, peaches, apricots, grapes, and blackberries.

WACO AND VICINITY.

In the suburbs of Waco, on both sides of Brazos River, pump irrigation has proved a paying investment. This is well established, not only by the data furnished, but by the fact that many are enlarging their plants and adding better machinery.

Plants east of Waco.—Two miles east of the city there is a cluster of a half dozen plants, all doing a successful business. E. Pordo has a surface well 19 feet deep and 6 feet in diameter, walled with brick. Ordinarily the water stands 3 feet in the well. A small centrifugal pump, having 2-inch discharge pipe, rests on the well covering and is operated by a 4-horsepower gas engine of local make. The head is 23 feet, into a flume 8 inches by 6 inches and 125 feet long, which empties into an earthen tank 60 feet by 60 feet on the inside. The system is reenforced by two Kirkwood windmills, which pump into elevated wooden tanks of 5,000 gallons capacity each. The windmills are 100 and 200 feet northeast of the tank, and each pumps out of a well of the same depth as the one just described. With good winds the windmills will supply sufficient water to irrigate the 3 acres. Adjoining the plant of Pordo is that of Robert Etheson, in all respects sim-

ilar to that of the former. The plant of Charles Myers consists of a 4-horsepower Lambert gas engine operating a plunger pump. The well is 32 feet deep, and the lift from the water to the flume is 38 feet. The water is pumped into a wooden tank of 6,300 gallons capacity, from which it is distributed to the garden through four outlet pipes 1½ inches in diameter. Instead of conveying the water to the different sections of land by ditches, a system of 1½-inch pipes is used. The land is watered from the pipes by means of a hose, or simply by removing the cap of the hydrant. It costs 65 cents a day to operate the engine for twelve hours. The soil is black loam, slightly impregnated with sand. The plant was first used in 1894. Ten acres are irrigated, although double that amount could be irrigated by the engine and the auxiliary windmill. Near the plant of Mr. Myers, Fred Stalte irrigates 4 acres by the use of a small gasoline engine and a windmill.

Etheson system.—One mile north of the foregoing cluster of plants, near Brazos River, A. Etheson irrigates 12 acres by the use of a gas engine pumping from a surface well.

Dismukes system.—In East Waco Ed E. Dismukes irrigates 16 acres with a 6-horsepower gasoline engine and a cylinder pump. At present the water is pumped out of a 6-inch pipe driven into 12 feet of water. The well which formerly existed was filled up and the 6-inch pipe substituted for it. The pipe is screened to prevent clogging by the sand. The suction pipe is 2 inches in diameter and the lift 9 feet. The water is pumped into a tank 30 feet by 120 feet by 5 feet deep, from which it is distributed.

Faulkner system.—About 1½ miles north of Waco is the fruit farm and garden of C. Faulkner, a tract containing about 400 acres. Of this about 350 acres are planted in fruit (pears, peaches, Burbank plums, apples, and blackberries), and about 30 or 40 acres form a garden in which vegetables, strawberries, and market produce are grown. The garden tract and a portion of that containing fruit trees (the late fruits) are irrigated from reservoirs or tanks on the highest points of the field, the water being supplied by an artesian well. The tanks are five in number, and consist of four levees thrown up to form a rectangular or roughly circular basin in which the water rises to a sufficient height to be conducted by gravity through pipes and ditches to all parts of the field. One of the tanks covers about 4½ acres and has an average depth of water of 8 feet. Two of them are about 120 feet by 150 feet and average 6 feet depth of water; the remaining two are smaller. The well was sunk in 1898, is 1,850 feet deep, has a 16-inch casing for about 20 feet from the ground surface, and a 6-inch delivery pipe. The water has a temperature of about 100° F., and is under a good pressure. It leaves a slight white deposit on the ground irrigated—so slight that it appears more like white frost than anything else—which, it is said, does not in any way injure the vegetation. The water is conducted from the tanks in ditches (piped under

the roads), and is distributed by side ditches and furrows. The average yield of pear trees is about 10 bushels, of peach trees about 5 bushels, and of Burbank plums (the only kind grown) 5 bushels. Apple trees have not yet begun to bear.

RICE IRRIGATION SYSTEMS.

GENERAL FEATURES.

The rice belt of Texas (fig. 18) extends from Sabine County, on Sabine River, to the Rio Grande, and at present includes two well-developed zones (the Beaumont and the Colorado Valley), which raise 75 per cent of the rice grown in the State, and several detached areas that are sure, with good management, to be the forerunners of extended systems in their respective localities.

In the Beaumont section the land is a level prairie, which heretofore has cut very little figure as an industrial factor. It is very flat, some of it having a slope of only 1 foot in 5,000 feet, and generally requires small levees and low lifts at the pumps. This flat section extends along the coast from Sabine River to the Rio Grande. The 250-foot contour above sea level is from 50 to 125 miles from the Gulf, while the strip 20 to 30 miles wide along the shore rises only a few feet above sea level.

In addition to this coastal belt the rice section has since 1897 been rapidly spreading back from the coast until it has reached Cuero, Fayetteville, and Hempstead on the west. In the flat sections the water is often obtained from bayous, and is frequently so impregnated with salt sea water that injury to the rice occurs. Rice must have an abundant supply of fresh water and a soil that is rich enough to nourish the plants and compact enough to hold the water, and it is being successfully grown in Texas wherever these factors are grouped, and where they do not exist naturally money and brains are grouping them with a twentieth-century effectiveness. No longer is the rice belt restricted to the old bayou country, but along the Brazos, the Colorado, the Guadalupe, and the Rio Grande more than 100 miles from the coast a high-grade rice is grown.

In addition, the irrigation of rice from wells will certainly prove of greater benefit to the Texas farmers than all of the big irrigation plants combined. The latter method of irrigation is in its infancy, but it is certain to become the chief factor in rice production in the State. The plant of George Vick, 2 miles east of Eagle Lake, is but the pioneer of many that will become established when the small farmer can, with a nominal outlay, convert his flat lands into a successful rice farm. A well 12 feet in diameter and 34 feet deep (7 feet of water), a traction engine to supply power, a submerged pump, an open box for a flume, a canal easily constructed—total cost $2,200—constitute Mr. Vick's equipment. With this 125 acres of excellent rice were

raised in 1900. This plant is now owned by Hudson & Ayres, and is referred to later in these pages.

The rice land is laid off in sections or "cuts" so that the extreme difference in elevation will not exceed 6 inches. The size of the cuts varies with the character of the topography. A cut is surrounded by levees or dikes, to hold the water, and it may be that a hillock or hole

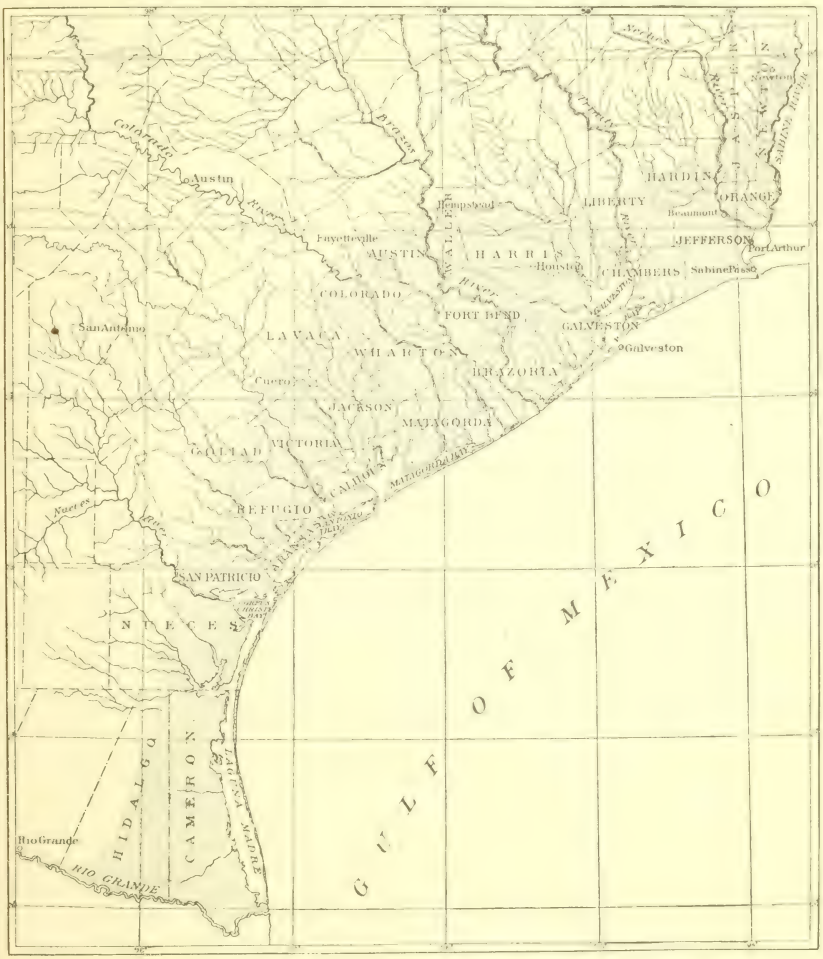


FIG. 18.—Map showing rice belt of Texas.

will occur in a cut. These can be ignored, however, for rice produces until time and the flow will level the one or fill the other. The water is pumped to the land by steam power, water power, or windmills, by far the greatest part of the work in Texas being done by steam.

From the best information obtainable in western Louisiana and eastern Texas it seems to be the consensus of opinion that it requires 9 gallons of water a minute for each acre of rice, or 1 second-foot to

each 50 acres. In the Beaumont section the rainfall often reduces the pumping considerably. During 1900, a wet year, some pumps were operated only four days. But a dry season will require the pumps to furnish the entire 9 gallons a minute for each acre, and it is not good engineering to estimate on less than that quantity, which is equivalent to 12,960 gallons per twenty-four hours per acre. If x is the number of acres to be irrigated and y the lift in feet, the weight of water to be supplied each second is $1.25\,x$ pounds, and the work done each second in pumping this amount is $1.25\,xy$ foot-pounds. The theoretic horsepower required would therefore be $\frac{xy}{440}$.

Thus for $x = 1{,}000$ acres and for a lift of $y = 22$ feet an engine exerting 50 absolute horsepower would be required. The estimated

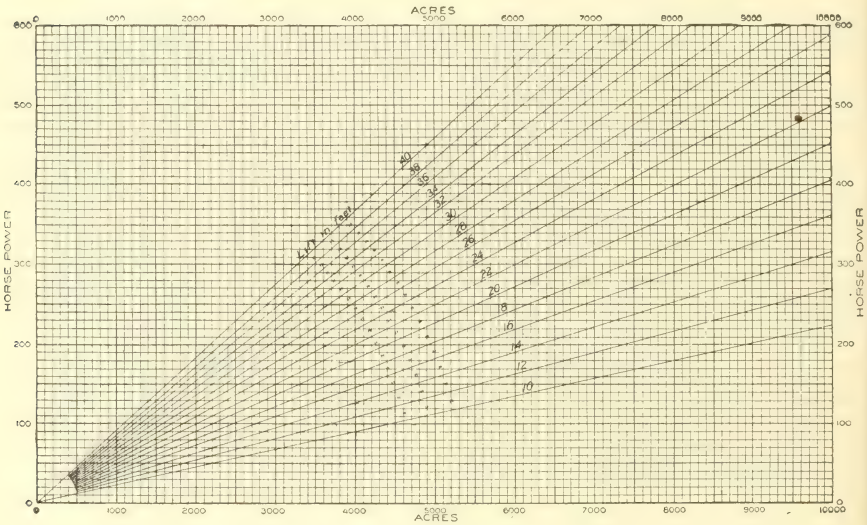


FIG. 19.—Diagram showing horsepower required for various lifts and acreages.

or claimed horsepowers of engines should be tested or reduced by a substantial fraction if disappointment in the capacity would be avoided.

By the aid of fig. 19 a person can at a glance determine the horsepower required to irrigate a tract of land. Given the lift and the number of acres to be irrigated, to find the horsepower of the engine first find the lift on the sloping lines (say 24 feet) and follow that line to the vertical line which corresponds with the number of acres to be irrigated (say 1,100), then follow the intersecting horizontal line to the left and read off the horsepower required—in this case 48—but in order to insure a safe margin an engine of 60 horsepower should be procured, and if the horsepower of the engine is based on the claims of agents a still larger margin should be allowed.

For some plants, owing to the contour of the ground, more than one lift is required, and more than one pumping station is necessary, the

pumping capacity of each station being the same, but the machinery in one station being heavier than that in the others, depending on the lift.

By means of flumes the water is led from the pumps to the canals, and from the main canals is turned into the laterals from which it is distributed over the land. The main canals are usually very wide, being in most cases intended to act as reservoirs.

The first experiments with growing rice in Texas were in 1862, the farmers depending on the rainfall to furnish the water. But this trusting to Providence in the matter of rice cultivation did not pay, and to insure success pump irrigation was resorted to. The culture of rice by irrigation began about 1893. Prior to that time it had been grown in only a small way in ponds and marshes for home use. The method of growing rice on a large scale by irrigation and with improved machinery is comparatively new, and is peculiar to the Southwest. Unlike Georgia and the Carolinas, where rice is still grown in the old way, the rice being planted in rows, the field flooded, and the water drawn off several times during the growing season, in Texas rice is sowed on comparatively high land with drills or broadcast, is cut with self-binders, and is thrashed from the shock or stacked, to suit the convenience of the farmer. The same kind of machinery is used in raising, harvesting, and thrashing rice that is used with other small grain, the only difference in the cultivation being that rice lands are flooded after the rice is up to a height of from 3 to 6 inches. The water kills the grass and weeds and causes the rice to grow rapidly.

In from ten to twenty days (depending on the grower and the nature of the soil before harvest) the levees on the lower side are opened and the water is drawn off by means of the ditches made in throwing up the levees. For some plants this drainage requires more engineering skill in the arrangement of the levees than in making them fulfill all the requirements for feeding the land with water. In Texas the practice is to sow the rice any time from April 15 to June 15. It is kept flooded from ninety to one hundred and ten days, one hundred days being the average. From $1\frac{1}{4}$ to $1\frac{3}{4}$ bushels are sown to the acre. The land is plowed and harrowed and prepared as for wheat. The outfit or equipment varies with the acreage. After the rice is planted and the water is turned on eternal vigilance is necessary to keep canals and ditches in order, to prevent breaks and the consequent waste of water and drowning out of part of the crop. It is by no means an easy crop to manage. From the first flooding until harvesting the work is a muddy history of patience. Just before the crop ripens the water is drawn off to permit the ground to harden enough to bear the binder. If the rains set in at this critical time it entails additional expense and trouble to save the crop. In this respect the rice farmers away from the coast have an immense advantage, for

there the rainfall aids during the flooding period and does not jeopardize the crop during the time of harvest. While the cost of pumping is more in the western part of the rice belt, the surety of an undamaged product will always overbalance the additional expense.

BEAUMONT SECTION.

The irrigation systems in the Beaumont section, which comprises the counties of Jefferson, Orange, Liberty, and Chambers, are shown in the maps forming figs. 20 and 21, and are described on the following pages.

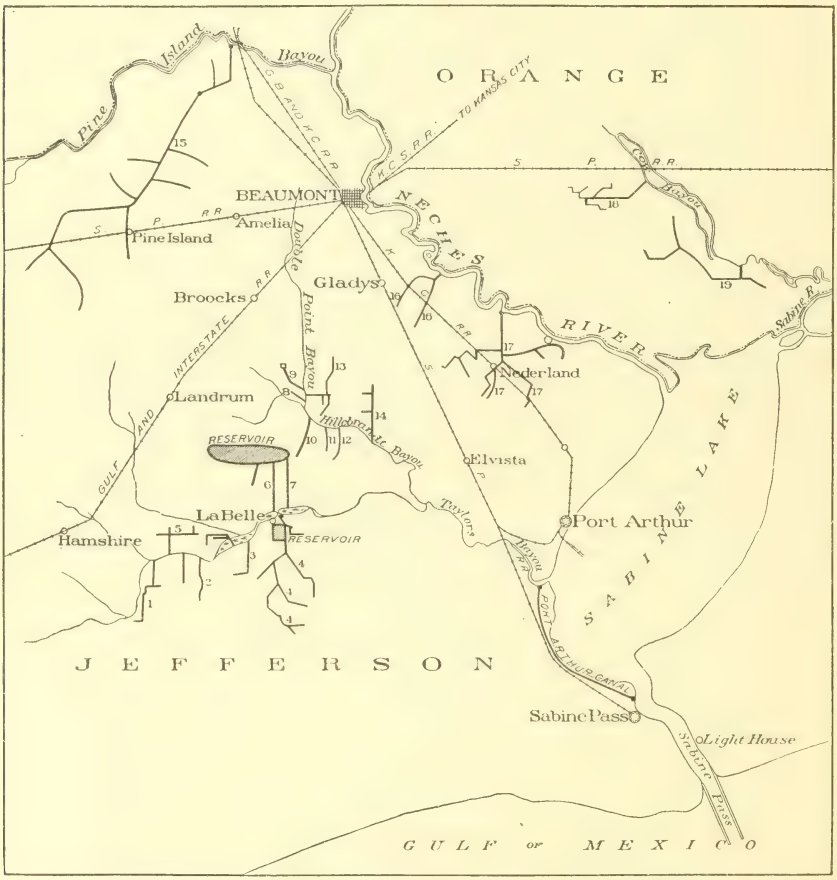


FIG. 20.—Map showing irrigation systems in the eastern half of the Beaumont section.

1. George Gill.
2. J. H. Garland.
3. J. C. Ward.
4. Jefferson County Rice Company.
5. J. H. Hoopes.
6. Lovell Brothers.
7. Ed. Moore.
8. Gulf Rice Growing Company.
9. Southern Rice and Trust Company.
10. C. A. Place.
11. Mr. Davis.
12. Schumacher & Fox.
13. Cameron & McClure.
14. Viterbo Brothers.
15. Beaumont Rice Company.
16. McFadden & Wiess Company.
17. Port Arthur Rice Company.
18. Des Moines Irrigation Company.
19. Cow Bayou Canal and Irrigation Company.

JEFFERSON COUNTY.

Of all the counties of Texas in which the people have tried rice growing by means of irrigation, Jefferson County undoubtedly stands first in extent of acreage and in successful cultivation.

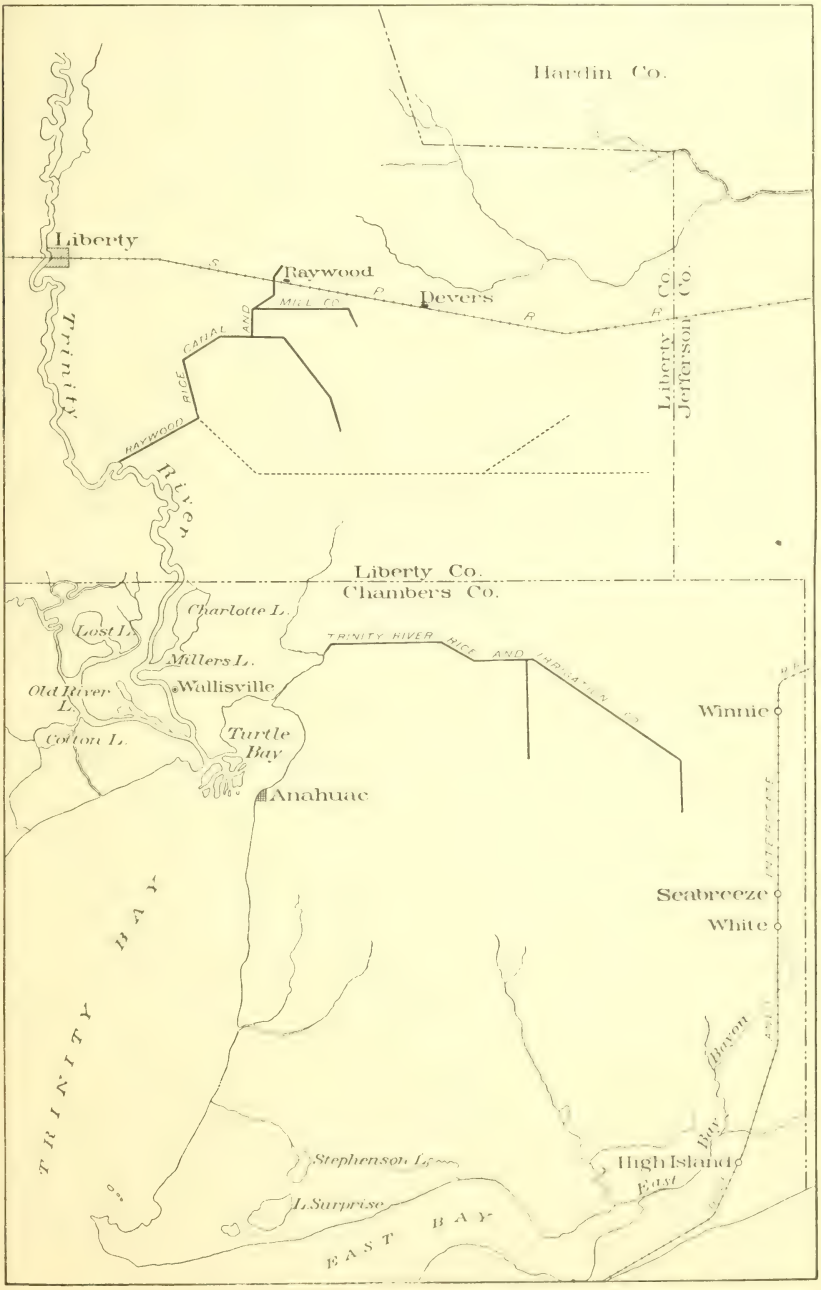


FIG. 21.—Map showing irrigation systems in the western half of the Beaumont section.

The rice farms and plantations are in two general districts, one in the valleys of Taylors and Hillebrandt bayous, above their junction in the southern part of the county, and the other along the valleys of Neches River and the Pine Island Bayou. All of the farms owned and operated by individuals are on Taylors and Hillebrandt bayous. There are also in the county five rice-growing companies, known as the Beaumont Rice Company, the McFadden & Wiess Company, the Port Arthur Rice Company, the Jefferson County Rice Company, the Southern Rice and Trust Company, and the Gulf Rice Growing Company.

The following is a list of the rice irrigators in the county, arranged in order going downstream:

Rice irrigators in Jefferson County.

Name.	Stream.	Acres irrigated.	
		1900.	1902.
George Gill	Taylors Bayou (S.)	600	1,500
J. G. Garland	do		750
J. C. Ward	do	900	700
Jefferson County Rice Co	do	1,800	2,300
J. H. Hoopes	Taylors Bayou (N.)		600
Bigham Bros	do	1,200	400
P. S. Lovell	do	850	760
Ed. Moore	do	100	60
Gulf Rice Growing Co	Hillebrandt Bayou (SW.)	150	300
C. A. Place	do	450	500
Southern Rice and Trust Co	Hillebrandt Bayou (NE.)	900	900
Cameron & McClure	do	550	680
Viterbo Bros	do	600	950
Beaumont Rice Co	Pine Island Bayou	12,000	15,000
McFadden & Wiess Co	Neches River	None.	9,000
Port Arthur Rice Co	do	4,000	8,500
	Wells		1,480
Total			44,380

General descriptions of the plants are given on the following pages; also, where obtainable, the opinions of the growers in reference to time of sowing, disposal of the straw, nature of the land, and other convictions drawn from experience.

The dry season of 1902 caused the impregnation of Taylors and Hillebrandt bayous with salt water, and the 10,000 acres of rice on these bayous suffered accordingly. It is claimed that the ship canal from Sabine Pass to Taylors Bayou has increased the danger from salt water in these bayous, and attention is here called to the necessity of a dam across Taylors Bayou at the mouth to keep back salt water.

TAYLORS BAYOU.

Gill system.—George Gill's farm is the westernmost irrigating from Taylors Bayou. The soil is of clay, with no sand, and is very hard to plow. Mr. Gill uses the drill and also sows broadcast, but he recommends the former method. His yield has averaged 7 sacks an acre. There are two complete pumping plants on the farm. One consists of an Ivens rotary pump, having a capacity of 9,000 gallons a minute

against a lift of 12½ feet, and a Skinner engine and 80-horsepower boiler made by the Columbia Boiler Works. The other plant consists of a Menge pump, having a capacity of 300,000 gallons an hour against a lift of 3 feet, and a Taylor compound engine and a boiler of the same make and steaming capacity as that of the other plant. The flume is 6 feet wide, 2 feet deep, and 24 feet long. The main canal is 60 feet wide and 3 miles long, with several laterals. The total cost of the equipment was about $5,000. Mr. Gill irrigated 400 acres in 1899, 600 acres in 1900, and 900 acres in 1901. For all purposes he recommends low-speed engines (though both of his engines are high speed) and slow-speed pumps, as they seem to give better satisfaction.

Garland system.—J. G. Garland's farm lies along Taylors Bayou, about 20 miles southwest of Beaumont. The soil is very sticky, although it works well when dry. Mr. Garland sows either with a drill or broadcast, from March 20 to about June 10, and uses the ordinary binder in reaping. While thrashing he saves sufficient straw for feeding purposes and burns the surplus. For the first rice sown irrigation is begun about May 20, depending on the season, and is continued until almost time of harvesting. The yield from this land has been 10 barrels to the acre, the price of seed from $3 to $5 a barrel.

He uses one pump, of the Menge pattern (manufactured by the estate of Joseph Menge at New Orleans, La.), having a capacity of 15,000 gallons a minute (33 second-feet) under a lift of 8 feet. A 75-horsepower Skinner engine drives the pump by means of rope transmission. The boiler used for steaming has a capacity of 90 horsepower, and was manufactured by the Union Iron Works and Skinner Engine Works, of Erie, Pa. There are two laterals—one a half mile long and the other three-fourths of a mile long. The total cost of the plant was about $2,700. With this equipment Mr. Garland irrigated 600 acres in 1899 and 750 acres in 1902.

Ward system.—The farm of J. C. Ward is the next one on the south side of Taylors Bayou. The soil is generally sandy, with a good clay foundation near the surface of the ground. His methods of sowing, cultivating, and reaping are as follows: Beginning about March 1, he continues to sow until the last of May, using either the drill or sowing broadcast. Irrigation is begun about the 1st of June, though this depends upon the weather. When matured, the rice is harvested with binders, and then thrashed. All the straw needed for feeding purposes is saved, the remainder is usually burned. The average yield has been 10 barrels (35 bushels) an acre, for which Mr. Ward has received $3 a barrel. There are two complete pumping plants on the farm. The pump at the larger station is of the Menge type, with a capacity of 720,000 gallons an hour (27 second-feet). A 100-horsepower Atlas engine is installed, with only an 80-horsepower Atlas boiler. At the other plant there is a 500,000-gallon Menge pump, an

engine of local make, and only a 30-horsepower boiler. The lift in each case is 9 feet. The larger plant cost $5,000, the smaller only $1,500. The flume is 60 feet long, 12 feet wide, and 4 feet deep; the box part is constructed of 2-inch planking. The main canal is from 60 to 40 feet wide and 2 miles long, and has several large laterals

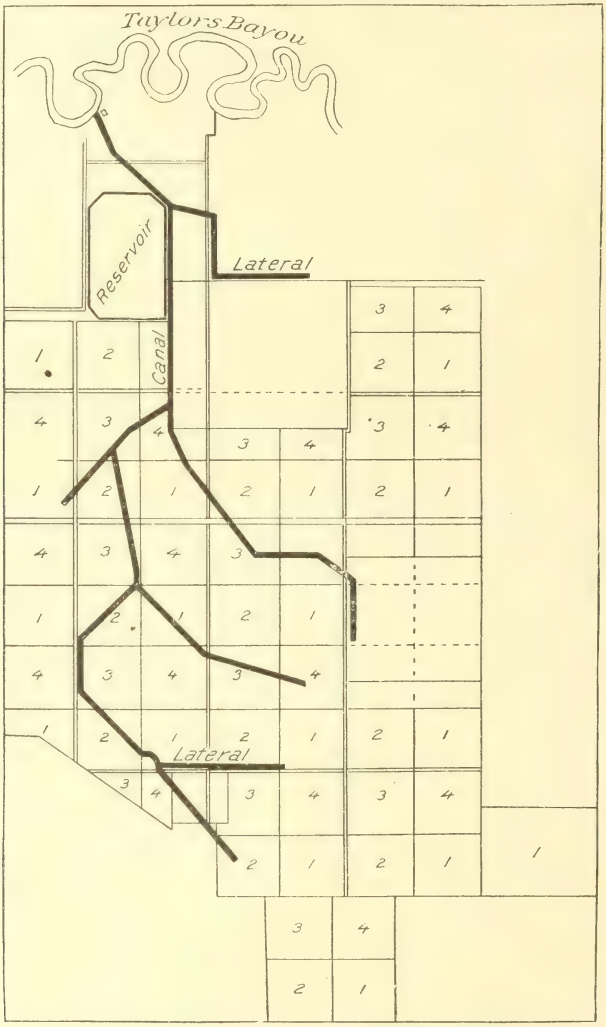
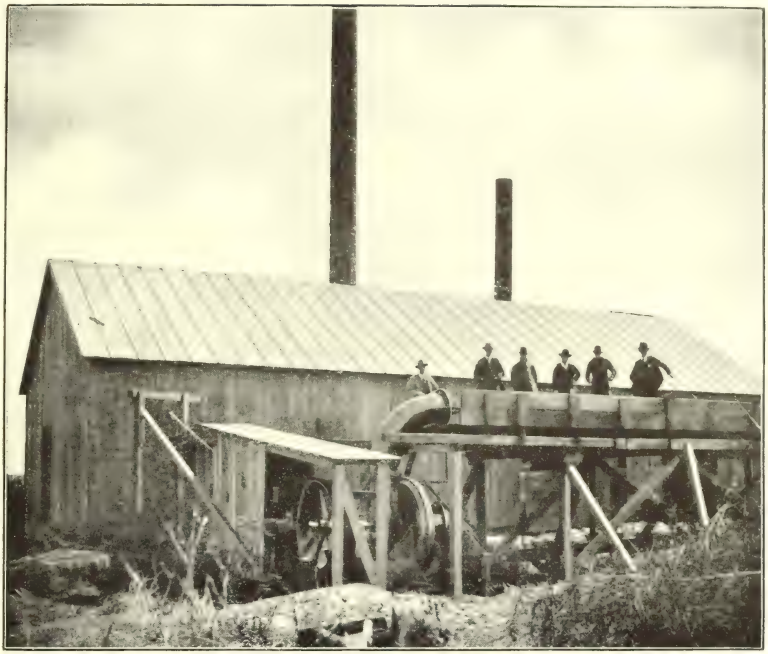


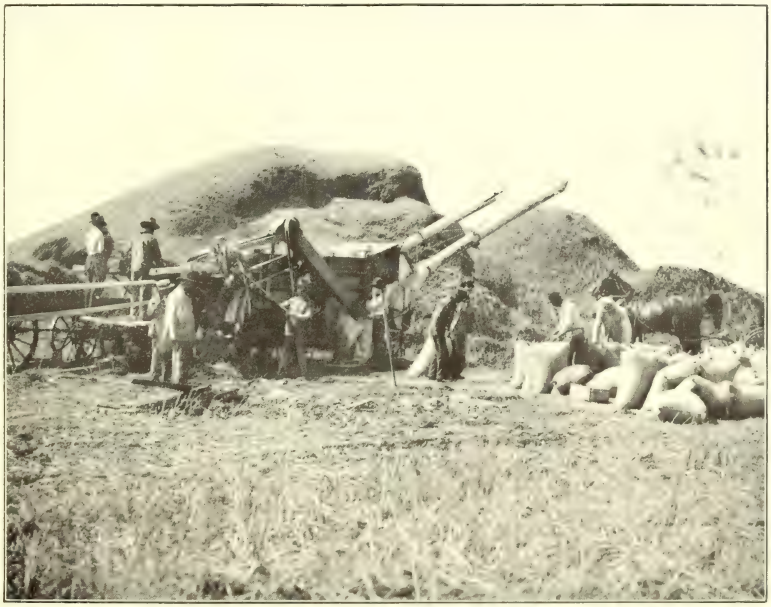
FIG. 22.—Map of Jefferson County Rice Company's farm, showing irrigation canals.

branching off. Mr. Ward irrigated about 400 acres in 1899 and 900 acres in 1900, but the plant is now leased to Bigham Brothers.

Jefferson County Rice Company system.—The farm of the Jefferson County Rice Company is 17 miles from Beaumont, and is the last one on the south side of Taylors Bayou, all the land below being marshy and subject to overflow from salt water. Two pumps, one 22-inch Marri and one 15-inch Ivens, of capacities of 20,000 and 7,500



A. PUMPING STATION OF JEFFERSON COUNTY RICE COMPANY.



B. RICE THRESHER AT WORK ON PORT ARTHUR IRRIGATION COMPANY'S PLANTATION.

gallons a minute, respectively, raise the water from the bayou against a lift of 15.1 feet. The engines are of the Erie make, of capacities of 150 and 50 horsepower, respectively. The boiler is of the same make, and has a steaming capacity of 200 horsepower. The flume is 12 feet wide, 3 feet deep, and 180 feet long, and discharges into a canal 100 feet wide. The soil is a deep, black, sandy loam and has a clay subsoil. In 1899 it yielded 8 sacks to the acre. This farm has been irrigated six years. Fourteen hundred acres were planted in 1899, but the number was reduced to about 800 acres in 1900. In 1901 about 3,000 acres were irrigated. Pl. VII, *A*, is a view of the pumping station. The smaller pump was installed in 1896, the larger (a 150-horsepower) in 1898. The company owns 10,424 acres of land, which they have divided into quarter sections and thrown open to actual settlers. So far 3,800 acres have been sold to settlers, on the crop-payment plan, at from $20 to $25 an acre, one-half of the crop being given to the company until the land is paid for. The highest point on the farm is at the pumping station, and this enables the company to flood the whole tract without additional lifts by pumping. To insure a full supply, a reservoir covering 500 acres has been constructed, with an average depth of 4 feet and a capacity of 2,000 acre-feet, or 1,300,000 gallons. A map of this farm showing the irrigation canals is shown in fig. 22.

Hoopes system.—J. H. Hoopes's farm is in the lowlands made by Taylors and Hillebrandt bayous. Some of the soil is black and waxy, some is black loam, and some is sandy, but all has a clay subsoil. The yield has been from 8 to 12 sacks to the acre. A Menge pump, manufactured in New Orleans, with a capacity of 16,600 gallons a minute, furnishes the water. The pump works against an average lift of 10 feet, varying with the stage of the water. An Erie engine of 60 horsepower is used, and an Erie boiler of the same steaming capacity. The flume is 32 feet long, 9 feet wide, and 1 foot deep, constructed of 1-inch boards and lined with galvanized iron, which is an exception to the ordinary flume in this district. The main canal is 100 feet wide and 1 mile in length. Six hundred acres were planted in 1899, 400 acres in 1900, and 600 acres in 1902. The total cost of the plant was about $4,000.

Moore system.—Mr. Ed. Moore's farm is near the Hoopes farm. The soil is a mixture of clay and loam. The yield last year was below the average, being only from 6 to 8 sacks to the acre. He uses an Ivens centrifugal pump having a capacity of 200,000 gallons an hour against a lift of 17 feet. One 60-horsepower engine, of the Cleveland make, operates it, steam being supplied by a 75-horsepower boiler. The flume is 200 feet long, 3 feet wide, and 1 foot deep. The canal is from 15 to 30 feet wide and 2 miles in length. One hundred and fifty acres were irrigated in 1899, 100 acres in 1900, and 60 acres in 1902.

Bigham system.—The plant of Bigham Brothers is on the north

side of Taylors Bayou, near Labelle. It consists of two pumps having discharge penstock 2 by 3 feet. The lift of one pump is 8 feet, of the other pump 12 feet. The power is supplied by two engines of 40 and 80 horsepower, respectively. The water is raised into flumes 30 and 100 feet long, and these discharge into the main canals, which are a half mile and 3 miles long, respectively. There were 400 acres in rice in 1899, 1,200 acres in 1900, and 1,200 acres in 1901, notwithstanding the unusual severity of the latter season. The yield in 1900 was 8,000 sacks, commanding $3 a sack. The soil is a black loam, and is well suited to rice culture. This firm operates the J. C. Ward farm.

Lovell system.—The plant of the Lovell Brothers (Willard G. Lovell, manager) is on the north banks of Taylors Bayou. It consists of an Ivens pump having a 21-inch suction pipe and an 18-inch discharge pipe, and estimated to have a capacity of 18,000 gallons a minute (40 second-feet) under a maximum lift of 18 feet. The plant is run by a Houston, Stanwood & Gamble engine of 100 horsepower. With an engine efficiency of 75 per cent this can pump only 275 gallons a second, or 16,500 gallons a minute. The flume is 146 feet long, 10 feet wide, and 3 feet deep. The length of the main canal is 3½ miles, the width 50 feet. One mile of the laterals is 20 feet wide, 1½ miles are 15 feet wide, and a half mile of them is 10 feet wide. In 1899, 1,100 acres of rice were sown; in 1900, 850 acres; in 1901, 850 acres; and in 1902, 760 acres.

HILLEBRANDT BAYOU.

Southern Rice Company system.—The plant of the Southern Rice Company is the northernmost diverting water from Hillebrandt Bayou. It is about 12 miles south of Beaumont. The plant is equipped with Ivens pumps having 22-inch suction pipes and 21-inch discharge pipes, operated by a 100-horsepower Chandler & Taylor engine, estimated to have a capacity of 15,000 gallons a minute (33 second-feet) under a lift of 13 feet. With an engine efficiency of 70 per cent, 71 horsepower will do this work. The water is delivered by the pumps into a flume 150 feet long, 8½ feet wide, and 4 feet deep. The main canal is 1½ miles long and 75 feet wide, and delivers into laterals 12 feet wide. The soil is black, with a clay subsoil. Water was rented in 1899, when 200 acres of rice were sown, yielding 2,000 sacks, which sold for $2.70 a barrel. The amount sowed in 1900 was 900 acres, yielding 7,000 sacks, which sold for $3 a barrel. In 1902 about 960 acres were sown.

Gulf Rice Growing Company system.—The farm of the Gulf Rice Growing Company is 10 miles southwest of Beaumont on Hillebrandt Bayou. The lift is about 12 feet, and the water is pumped by a 90-horsepower engine. The soil is a clay loam, 300 acres of which, in rice, were irrigated in 1902.

Place system.—The plant of C. A. Place has one Morris pump

having 15-inch suction and 12-inch discharge, operated by a 25-horsepower Westinghouse "Junior" engine, having a maximum capacity of 10,000 gallons a minute (222 second-feet) against a lift of 12½ feet. The water is delivered into a flume 28 feet long, 4 feet wide, and 2 feet deep, which in turn delivers it into the canal, which is 1 mile long and 60 feet wide. The soil is clay and black loam, with a subsoil. Two hundred and fifty acres, in rice, were irrigated in 1899, 450 acres in 1900, and between 450 and 500 acres in 1901. The yield in 1900 was 3,400 sacks, commanding $3 a sack. The plant cost $2,500. Previous to 1899 other parties owning this farm had irrigated 125 acres.

Cameron & McClure system.—The rice plantation belonging to Messrs. Cameron & McClure is on both sides of Hillebrandt Bayou. The soil is light, but it has a fine clay subsoil which retains the water well. The rice is sown from March 25 to May 1, and if the season is not rainy irrigation is begun when the rice is about 6 inches high. The yield has been from 7 to 10 sacks to the acre, and the price received ranges from $1.25 to $3.40. The lower prices were received for rice of poor quality, much of it being damaged by what is termed "red rice." The reaping is done with the ordinary harvester and binder. The owners of the plantation have found that the straw makes very good hay.

Owing to the farm being on both sides of the bayou, there are two complete pumping plants. At one of the plants there is in use a 6-foot Menge pump, having a capacity of 12,000 gallons a minute (27 second-feet) against a head of 10½ feet. The engine is of the Skinner type, of a capacity of 75 horsepower, and receives steam from a 100-horsepower boiler. The other plant has a 12-inch pump of the Van Wie make, which has a capacity of 7,500 gallons a minute (17 second-feet) against a head of 10½ feet. This pump is run by a 40-horsepower Skinner engine which is supplied with steam by a 50-horsepower Van Wie boiler.

The flumes are 40 and 60 feet in length, 12 and 8 feet wide, and 12 inches deep. They are constructed of 4-inch by 4-inch timber in the bents, while the sides and bottoms are made of 12-inch planking.

Four hundred and fifty acres were irrigated during the year 1899, 550 acres in 1900, and 680 acres in 1902.

Viterbo Brothers system.—This system is 12 or 14 miles southwest of Beaumont. One Menge pump, costing $500 and having a capacity of 25,000 gallons a minute against a lift of 7 feet, is used. Two boilers, each of 50 horsepower, furnish the steam to a 75-horsepower engine. The canal is 40 feet wide and 2½ miles in length. A reservoir, covering an area of 225 acres and having a depth of 6 feet, holds the storage water. There are 1,000 acres leveed in, but not all of this is planted in rice. The yield on this land has been from 7 to 18 sacks to the acre. Six hundred acres were sown in 1899, 600 acres in 1900, 700 acres in 1901, and 950 acres in 1902.

PINE ISLAND BAYOU.

Beaumont Irrigation Company system.—This company has been operating the largest rice plantation in Texas. It is in the northern part of Jefferson County, lying along the south side of the Pine Island Bayou. There are two lifts. The first one is at the crossing of the

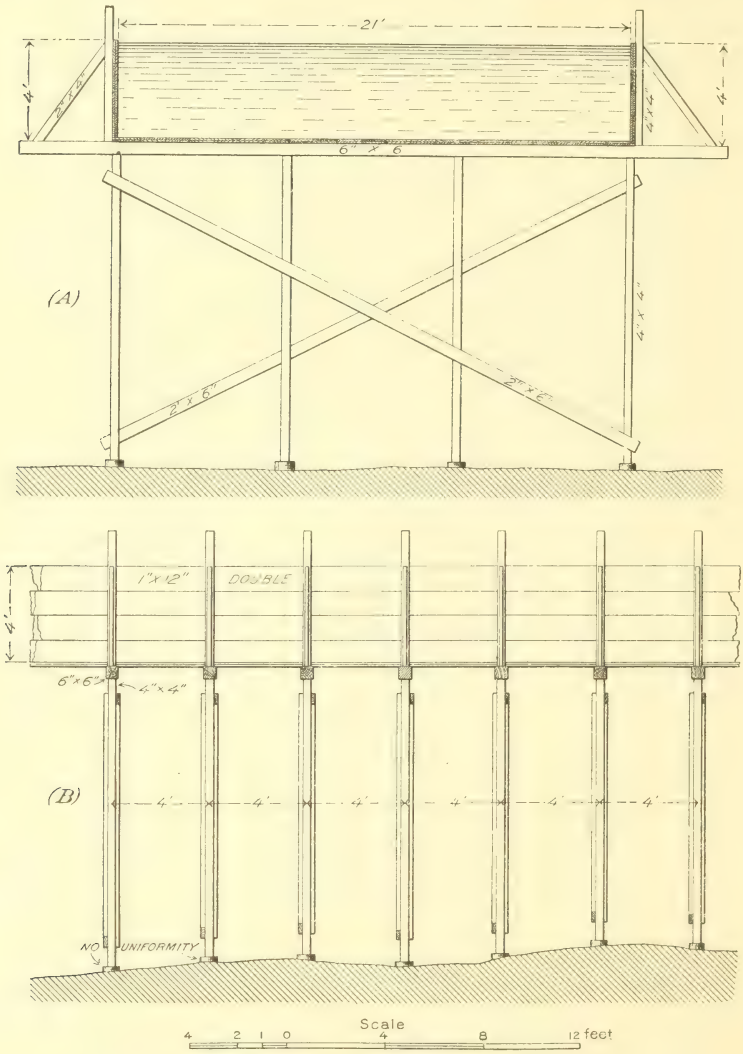


FIG. 23.—Elevation and section of flume of Beaumont Irrigation Company.

Southern Pacific Railroad, and raises the water from Pine Island Bayou. Until 1890 there were at this lift two Connersville compound blower pumps, each having a capacity of 25,000 gallons a minute. To each of these pumps was attached one Hamilton-Corliss engine of 250 horsepower, steam being supplied by 300-horsepower boilers. In 1900

another pump of the same capacity was installed, with a corresponding engine and boiler. The pumps work against a lift of 31 feet, and have always given satisfaction. They are 15 feet above the water in the bayou, and force the water 16 feet into the flume. Wood is used altogether for fuel. The flume, shown in elevation and section in fig. 23, is 4 feet deep, 21 feet wide, 1,500 feet long, and has a total fall of only 4 inches. The box part is constructed of 1-inch by 12-inch planks, the floor and sides being double planked, and all joints broken and tarred. The floor rests on 6-inch by 6-inch sills, which are supported by four 6-inch by 6-inch uprights. The distance between the bents is 4 feet. The canal is 150 feet wide.

For 3 or 4 miles from this lift the land is covered with pine growth and is somewhat broken. The portion covered with timber would be expensive to prepare for cultivation, and that broken could not be irrigated. So the water has to be carried to almost the second lift before the farms are reached. The whole plantation is on the prairie, the land gradually rising from the first lift. It is about 5 miles from the first lift to the second lift, where the water is raised 11 feet. The pumps here, both the two old ones and the new one, have the same capacity and are of the same make as those at the first plant, but owing to the low lift they are of lighter construction. The engines also are of the same make, and are of 150 horsepower each. The same may be said of the boilers, the steaming capacity of which is 200 horsepower. The flume is similar to the one at the first plant, but it is only about 200 feet long.

It is estimated that about $135,000 has been expended on this plantation. The company irrigated about 5,000 acres in 1899, a large part of which was rented to individuals. In 1900 12,000 acres were irrigated, 4,000 of which were cultivated by the company, the remainder being rented to 37 individuals. The custom of renting is to charge 2 sacks (162 pounds) an acre for water alone and 2 additional sacks where the company rents the land, making a total of 4 sacks an acre where both land and water are rented. The average yield on this plantation is about 10 sacks to the acre, though some of the tracts may run up as high as 20 sacks. The canals and laterals follow the general contour of the ground. Machinery has been added from time to time, till now (1902) the river plant has three 350-horsepower and two 250-horsepower engines and two 36-inch and two 48-inch Connersville and one 60-inch Roots pumps, while at the second lift there are two 200-horsepower and two 125-horsepower engines and two 36-inch Connersville and two 36-inch Morris pumps. In 1902 there were irrigated 14,615 acres.

NECHES RIVER.

Port Arthur Irrigation Company system.—This plantation is on Neches River, about 12 miles southeast of Beaumont and about the same distance northwest of Port Arthur. The pumping plant is on the banks of the river, from which the water is pumped, the lift being

21 feet. The plant has been in operation three years. Until the season of 1900 there was in use only one 18-inch Ivens pump, having a capacity of 18,000 gallons a minute. In 1900, however, two 24-inch Ivens pumps, each having a capacity of 24,000 gallons a minute, were installed. The other operating machinery, including that installed with the new pumps, consists of two 125-horsepower boilers, four 100-horsepower boilers, one Chandler & Taylor engine, and one new Corliss engine of 350 horsepower.

The flume was formerly about 100 feet long, 20 feet wide, and 4 feet deep, but in 1900 this was increased in width to about 60 feet. The main canal is 100 feet wide and has very high levees, but it is doubtful whether this is the most economical form of construction. One thousand seven hundred acres were irrigated in 1899, 4,000 acres in 1900, and 7,000 acres in 1901. A charge of 2 sacks is made for water and 2 sacks for land rented. Pl. VII, *B*, is a view of a rice thresher at work on this farm. The yield in 1899 was about 14 sacks an acre. The rice grows very rank, varying in height from 5 to 7 feet. Some of the straw was baled and found to make very good hay; the remainder was burned. All of the land on which this rice is grown is black and sticky. (See map, fig. 20, for plot of the main canal and laterals.) This company irrigated 8,500 acres in 1902.

McFadden & Wiess system.—This plant is on the western bank of Neches River, or rather on the edge of the marsh that lies between the river and the rice lands, about 7 miles southeast of Beaumont. The water is conveyed from the river to the plant by a canal dredged out of the marsh. Its length is 2,000 feet, width 40 feet, and depth 6 feet. The plant was located on the edge of the marsh, a foundation being obtained by driving piles 3 feet apart under the power and pump house. On top of the piles several courses of grillage work were laid, and this was capped by a cement foundation for the machinery.

There are two Connersville rotary cycloidal pumps, with suction pipes 2½ by 6 feet and discharge pipes 4 feet in diameter. The pumps are run by two Hamilton-Corliss compound condensing engines of 250 horsepower each. The capacity of the plant is estimated at 70,000 gallons a minute (156 second-feet) under the lift of 22 feet, which would require an efficiency of 78 per cent in the machinery. The main canal is 6 miles long, 100 feet wide, and 2½ feet deep. The plant cost $65,000, the machinery costing $40,000. Four thousand acres of rice were irrigated in 1901, and 9,000 acres in 1902.

WELLS.

In addition to the canal plants in Jefferson County there are a number of plants that derive their water from wells. These are located near Hamshire and China. The well of George J. McManus, near Hamshire, will serve as a type of those in this section. There are two wells 40 feet apart, connected in the pit 22 feet deep. One is

81 feet deep; the other 180 feet. The water-bearing sand was found to be 72 feet thick, and the screw was put in in three lengths of 20 feet each. It consisted of an 8-inch pipe with three-fourths inch holes bored with 1¼-inch clear space between them. The pipe was then wrapped with No. 16 wire, one-fifth of an inch apart, and on this was wrapped the copper gauze of mesh 60, 30, and 40 to an inch. The 6-inch Van Wie pump is operated by a 22-horsepower Gear-Scott steam engine, using Beaumont oil for fuel. From this plant 120 acres of rice were irrigated in 1902. In the same neighborhood H. C. Wheeler has a well plant that derives its water from flowing wells. At one of these wells it was 207 feet to the water-bearing sand that furnishes the supply. This is 43 feet in thickness, making the total depth of this well 250 feet. Near Hamshire the acreage from wells was: McManus, 120; Wheeler, 300; Heisig, 185; total, 605 acres.

The acreage around China from well plants was. Hal Aldridge, 125; J. W. Kirby, 200; Burrows, 200; Southwestern Company, 200; Spivy, 150; total, 875.

ORANGE COUNTY.

COW BAYOU.

Cow Bayou Canal and Irrigation Company system.—Rice irrigation has been conducted in Orange County for about ten years. In 1891 F. H. Catron installed a 50-horsepower engine to operate a Menge pump under a head of 8 feet, the plant being located on Cow Bayou, about 6 miles southwest of the town of Orange. The ditch was 1 mile long and 20 feet wide. The plant cost $6,500, the canals and laterals costing $5,000 and the engine and pumps $1,500. The capacity of this plant was 5,000 gallons a minute, or 11.11 second-feet. With an efficiency of 75 per cent for the engine the pumping of this amount of water requires only 14 horsepower. Six hundred acres of rice were irrigated in 1896. This system has passed into the control of the Cow Bayou Canal and Irrigation Company, which has remodeled the whole plant, removing the pump to a more advantageous location and installing one 250-horsepower Viker-Corliss engine having an 18-inch by 36-inch cylinder and operating two 18-inch Ivens double-suction latest improved pumps having a capacity of 30,000 gallons a minute (66.67 second-feet) against a lift of 14 feet. There are 5½ miles of main canal. (See fig. 20.) For the first 1.5 miles the width is 80 feet, for the next 1.5 miles it is 50 feet, and for the remainder of the distance it is 60 feet. The water is first pumped into a flume 20 feet wide, 4 feet deep, and 300 feet long. The cost of the plant, including engines, pumps, canals, laterals, flumes, etc., was $25,000. Three thousand acres were planted in rice in 1901.

Des Moines Rice Company system.—About 7 miles west of Orange and 4 miles from Terry is the plant of the Des Moines Rice Company, which consists of an Ivens pump having 21-inch discharge pipe, oper-

ated by a 125-horsepower Atlas engine, having a claimed capacity of 20,000 gallons a minute (44 second-feet) against the lift of 17 feet. This duty will require an efficiency of 68 per cent in the engine. Pine wood is used as fuel, and it takes about 5 cords each twelve hours. The flume is 200 feet long and 10 feet wide. The main canal is 3½ miles long and 100 feet wide, and there are 4 miles of branches varying in width from 20 to 50 feet. (See fig. 20.) The plant was installed in 1899, and 960 acres of rice were sowed that year, commanding a price of $3.25 a barrel of 162 pounds. In 1900, 1,400 acres were planted, and in 1901 about 1,600 acres. The soil is a black loam.

ADAMS BAYOU.

Orange County Rice Company system.—The plant of this company is on Adams Bayou, 4 miles from Orange. It consists of a 24-inch Ivens direct-connected pump and a 100-horsepower engine. Under a lift of 8 feet the plant has a capacity of 20,000 gallons a minute. In 1901 about 2,500 acres were irrigated, and 3,500 acres in 1902. The first lift is 16 feet, and the two pumping plants, 2 miles apart, when visited in August, 1902, had all the rice well watered, and the whole crop was healthy in appearance.

Clark system.—The Clark Canal Company (A. T. Chenault, manager) is north of Orange and takes its water from the east side of Adams Bayou, under a lift of 16 feet. The machinery consists of a 50-horsepower Morris steam pump, and 500 acres were planted in 1902.

Giles system.—The plant of Giles Brothers takes its water from Adams Bayou, on the west side, under a lift of 18½ feet. One 50-horsepower Ames engine operates the Menge pump, with a 4 by 4 penstock. In 1902 550 acres were planted.

Acreage in Orange County.—The acreage in Orange County is as follows: Cow Bayou Company, 4,500; Orange County Company, 3,500; Des Moines Company, 1,200; Samuel Wilson Company, 600; Clark Canal Company, 500; Giles Brothers, 550; total, 10,850 acres.

CHAMBERS COUNTY.

TURTLE BAYOU.

The Trinity River Rice and Irrigation Company take their water from Turtle Bayou and Trinity River, 22 miles south of Liberty. (See fig. 21.) The plant consists of four large pumps, having 24-inch suction and discharge pipes, and a capacity of 20,000 gallons a minute each, or a total of 80,000 gallons a minute (173 second-feet), against a lift of 32 feet. There are four 250-horsepower engines, exerting a total of 1,000 horsepower (estimated). However, with an efficiency of 70 per cent it requires only 781 horsepower to pump the estimated quantity. Three of the pumps should be able to do all of the work. There are three flumes of a total length of 2,400 feet, a width of 15 feet, and a depth of 40 inches and 16 miles of main canals 100 feet wide and 10 miles of laterals 40 feet wide. The plant cost $13,000, and in a dry

season can irrigate 9,600 acres of rice with the usual evaporation. In 1900, 6,000 acres of "Providence" rice were cultivated, producing 29,000 sacks, which brought $3 a barrel. A sack averages about 180 pounds, while a barrel is always 162 pounds. The company sowed 9,000 acres in 1902. Generally they sow during May and June, using about 60 pounds to the acre. Renters are charged one-fifth of the crop for water, one-fifth for land, and one-tenth for seed—i. e., the company furnishes land, seed, and water, and receives half of the crop.

LIBERTY COUNTY.

TRINITY RIVER.

The Raywood Rice Canal and Milling Company has one of the largest plants in Texas. It is on the east side of Trinity River in Liberty County (see fig. 21), and cost $200,000. It was not installed until the latter part of 1900, but owing to excessive rains the company raised a good average crop of "Providence" rice that year. There are 10 miles of main canal from 100 to 150 feet wide, and 25 miles of main laterals from 60 to 80 feet wide. There are three lifts aggregating 70 feet, with a pumping station at each lift. The pumps are of the Root rotary pattern. Those at the river station have an estimated capacity of 45,000 gallons a minute (100 second-feet) under 16 feet lift. The suction pipes are 3 by 8 feet. Four of the pumps have circular discharge pipes 5 feet in diameter; the other two have rectangular discharges 3 by 8 feet. The pumps at the river station are operated by two 475-horsepower Lane & Bodley engines. The second station is equipped with two 375-horsepower engines operating two Root rotary pumps under a lift of 24 feet. The third station has two 250-horsepower engines operating two pumps having 5-foot circular discharge and suction pipes. The head at the latter station is 30 feet.

The soil is a black loam. Six thousand acres were cultivated in 1900, producing 50,000 sacks, which sold for $3.25 a sack. In 1902 the company planted 15,000 acres. The rice is sowed by a drill or broadcasted in April, May, and June, 1⅓ bushels to the acre. The land is let out to renters on the one-half plan—i. e., one-fifth of the crop for land, one-fifth for water, and one-tenth for seed. In 1901 oil was used for fuel, the cost being about one-third that of coal.

WELLS.

Near Stilson, 32 miles east of Houston, on the Southern Pacific Railroad, Brown & Son have a rice plant, the water for which is obtained from an artesian well 405 feet deep. The pit is 17 feet deep. The first 280 feet are of 8¼-inch casing, the remainder of 5⅝-inch casing. A 22-horsepower Port Huron traction engine supplies the power required to operate the 6-inch Morris pump, which raises the water 12 feet into a flume. The land is composed of a black prairie soil. One hundred and sixteen acres were irrigated in 1901, producing 870 sacks of rice. In 1902 200 acres were planted.

N. B. Sapp has an 8-inch artesian well 380 feet deep. In boring

this well a cypress log was struck at a depth of 360 feet. The operating machinery consists of one 18-horsepower Foos gasoline engine and two 16-inch Morris submerged pumps working under a lift of 8 feet. Water was not procured in time for the 1901 crop.

The well at the plant of the Hill-Brown Rice Land and Irrigation Company (C. A. Brown, manager) is an 8-inch, 485 feet deep, the water rising to within 10 feet of the surface. The machinery consists of a Morris direct-connected engine 8 by 8 inches and two 8-inch Morris pumps, the steam being supplied by two 30-horsepower Erie City boilers. The season of 1901 was so dry that no rice was planted. Additions have been made to the plant of this company, and in 1902 the crop was expanded to 1,000 acres.

HARRIS COUNTY.

Harris County systems.—Nearly 90 wells in Harris County are furnishing water for rice irrigation, over half of these being located in the vicinity of Clodine. The following is a list of the plants in this county: Sheldon canal, 2,000 acres; Harris Rice Company, 600 acres; F. B. West, 150 acres; J. E. Ross, 80 acres; A. W. Wilkerson, 250 acres; W. H. Myers, 75 acres; Conrad Bering, 125 acres; C. L. & C. H. Bering, 200 acres; Baldwin H. Rice, 280 acres; Meadow Brook Company, 3,600 acres; S. P. Dickey, 640 acres; F. E. Markeley, 60 acres; J. H. O'Donnell, 650 acres; J. E. Cabaniss, 75 acres; A. Stockdick, 40 acres; E. Couthwaite, 65 acres; plants at Stella, 75 acres; T. J. Roberts, 60 acres; Mrs. Ida W. Baker, 75 acres; total, 9,100 acres.

Sheldon system.—Two and one-half miles from Sheldon, 16 miles east of Houston, the Sheldon Canal Company takes the water for its 2,000 acres of rice this season from the San Jacinto River against a 40-foot lift. The plant consists of one 300-horsepower Corliss engine and one 18-inch Van Wie centrifugal pump. The water is delivered into a flume 226 feet long, which in turn delivers it into the canal, which is 120 feet wide and 4 miles long. The land commanded by the canal lies on both sides of the Southern Pacific Railroad.

O'Donnell system.—Thirteen miles south of Houston, near Erin, on the Santa Fe, J. H. O'Donnell has six wells, 50 feet apart. These are all under 98 feet in depth and have 46 feet of water-bearing sand and gravel; the whole length in sand is screened, and the water rises in the well to within 4 feet of the surface. The power is supplied by four 28-horsepower Fairbanks gasoline engines, which operate the 5-inch Morris pumps. These are placed in pits 15 to 17 feet deep, and are operated in batteries of three each. The soil is black hog wallow, and 650 acres were irrigated during the season of 1902.

Meadow Brook system.—On the Meadow Brook farm, northeast of Clodine, Fort B. Smith has drilled forty-seven wells and has twelve complete plants, ten operated by steam and two by Fairbanks gasoline engines. A complete plant consists of a central steam boiler,

using oil for fuel, and two or three engines, located in either opposite directions from the boiler or in such position as to form a right angle with the central plant. Thus one of these plants consists of a 125-horsepower Erie City boiler operating two 35-horsepower engines, which run the centrifugal pumps. Two wells are connected by piping in each pit, and one pump is then connected to the common junction. These companion wells are about 20 feet apart and are usually 150 deep and 10-inch bore.

Dickey systems.—Sixteen miles west of Houston and 1½ miles north of Daisy, S. P. Dickey has a rice farm where 640 acres were irrigated this season from five wells. These wells are of an average depth of 200 feet, and the power to raise the water is supplied by four 16-horsepower Fairbanks-Morse gasoline engines and one 25-horsepower steam engine. South and southwest of Clodine, in Fort Bend County, are located the well plants of B. A. Evarts, with 125 acres; H. F. Ring, with 165 acres, and F. E. Jones and S. M. Gordon, with 500 acres. The wells are usually 110 and 250 feet deep, connected in the same pit by a T joint.

Seven miles northwest of Houston C. L. and C. H. Bering have a rice farm on the Buffalo Bayou, from which water is taken. The lift is 50 feet. The soil is a black hog wallow. One hundred and fifty acres were irrigated in 1901, commanding from $3 to $3.75 a sack. The plant consists of one 10-inch Hooker duplex steam pump and a 60-horsepower boiler, the capacity being estimated at from 1,500 to 1,800 gallons a minute. In 1902 200 acres were irrigated.

Near the plant just described Conrad Bering had 87 acres in rice in 1901, which he irrigated from three wells, 400, 450, and 500 feet deep, and all being flowing wells the lift is very slight. The wells cost $1,500 each. The 8-inch Knowles duplex pump is on the surface. The yield was 17 sacks to the acre, selling for from $2.75 to $3.50 a sack. In 1902 125 acres were irrigated.

Eighteen miles east of Houston, on Bear Bayou, the Harris County Rice Company (Radford & Co.) had 110 acres of rice in 1901, yielding 1,040 sacks, commanding $3.40 a sack. Their engine is a 125-horsepower Watertown high-speed engine, and their pump a 15-inch Lawrence. The lift is 42½ feet, and the estimated capacity 7,000 gallons a minute. The main canal is 40 feet wide and 1.6 miles long. During the season of 1902 600 acres were irrigated.

Systems near Katy.—In the vicinity of Katy Messrs. J. E. Cabaniss, A. Stockdick, W. J. Nelson, William Eule, and T. G. Roberts have well plants ranging in capacity from 40 to 90 acres for this year. The wells are from 93 to 130 feet total depth and have screens from 12 to 20 feet long. Cabaniss and Eule use Foos gasoline engines of 22 and 14 horsepower, respectively; Stockdick uses a 22-horsepower Fairbanks-Morse, while Nelson and Roberts use steam engines. The Morris pumps are used by Cabaniss, Eule, and Roberts, while Eule

has a Van Wie and Stockdick a Ganed. The acreage is as follows: Cabaniss, 75; Stockdick, 40; Nelson, 90; Eule, 50; Roberts, 60.

Three miles from Genoa, on the Galveston, Houston and Henderson Railroad, A. W. Wilkerson has an irrigation plant consisting of two stations about a half mile apart. At one station there is a 22-horsepower portable engine and an 8-inch Morris pump; and at the other station a 7-horsepower Foos gasoline engine running a 6-inch Morris pump. The water is obtained from 8¼ inch artesian wells 560 feet deep. The soil is a rich black prairie soil. Two hundred and fifty acres were irrigated in 1902.

GALVESTON COUNTY.

Six miles east of Alvin, in Galveston County, near the junction of the Chigre Bayou with Clear Creek, Berry W. Camp, of Houston, has in operation a rice farm of 1,000 acres, which yielded 86 bushels to the acre in 1901. A 150-horsepower Corliss engine operates a 15-inch Van Wie centrifugal pump, which delivers 8,000 gallons a minute (18 second-feet) against a lift of 40 feet. The water is pumped out of an elliptical basin 40 feet across and 17 feet deep, which was excavated in the banks of the bayou and walled in with sheet piling and floored with heavy timber, and is discharged into a flume 2 feet by 6 feet 2,000 feet long and delivered to the main canal, which is 25 feet wide and 2 miles long. Both the Japan and the Honduras rice were sowed, 500 acres of each, the seed being imported for the purpose; 1¾ bushels were sowed to the acre. The soil is black, from 3 to 4 feet deep with a clay subsoil. The best machinery for handling the rice has been introduced. The thresher is the latest improved. It threshes, feeds itself, stacks the straw, sacks the grain (two sacks at a time), and has a capacity of 2,000 bushels every eight hours. In 1902 800 acres were planted.

One and one-half miles south of Algoa Mr. R. B. Halley sunk seven wells from 42 to 45 feet deep early in 1901, arranging them in a battery formation, four on one side and three on the other. Two 4-inch wells connect with a 6-inch pipe, and this 6-inch pipe and a 4-inch pipe join and unite with an 8-inch pipe, while another 4-inch pipe unites with the 8-inch pipe. On the other side two 4-inch wells join with a 6-inch pipe, and this 6-inch pipe and a 4-inch pipe unite with an 8-inch pipe, which is bushed into a 10-inch pipe. The two 10-inch pipes form a T to the pumps. The operating machinery consists of a 22-horsepower Foos portable gasoline engine and an 8-inch Morris vertical suction pump. The pumps are placed 8 feet below the surface. The water rises to within 4 feet of the surface of the ground. After the pumps are started the water level is lowered 10 feet, giving a lift of from 18 to 22 feet. The soil is black prairie soil. The water supply for 1901 failed, and only 250 sacks of "Providence" rice were raised.

BRAZOS VALLEY SECTION.

WASHINGTON COUNTY.

East of the Colorado Valley and from the country along the Santa Fe Railroad to Trinity River there are a number of plants, but they can not be classed in any system geographically distinct. They are in the counties of Washington, Austin, Waller, Fort Bend, Harris, Brazoria, and Galveston. The highest plants in this group are in Washington County and take their water from Brazos River. They are owned by W. E. Buchanan, Heber Stone, and J. P. Buchanan, all residents of Brenham. In 1902 775 acres were irrigated.

The plant of W. E. Buchanan is about 18 miles from Brenham. It consists of a 35-horsepower Atlas engine and an 8-inch Morris pump, having an estimated capacity of 3,500 gallons a minute (nearly 8 second-feet) under the lift of 40 feet. The soil is that of the rich Brazos bottom lands, and 200 acres were planted in 1902.

The plant of Heber Stone is in Waller County, about 18 miles from Brenham. It consists of a 125-horsepower Beaumier Brothers' engine and a 15-inch Van Wie pump. The lift is 40 feet, and the estimated capacity 7,000 gallons a minute (15.6 second-feet). The machinery did not arrive in time for the crop of 1901, but it is the intention to irrigate 200 acres in 1902.

J. P. Buchanan's rice farm is in the neighborhood of the former, but is in Washington County. A 125-horsepower Beaumier Brothers' engine runs the 15-inch Morris pump against a lift of 40 feet, and it is estimated that the capacity is 7,000 gallons a minute. The soil is the famous Brazos bottom land. Forty acres were irrigated in 1901, yielding 50 bushels to the acre, and 625 acres were irrigated in 1902.

The floods in the Brazos in the early part of August, 1902, destroyed most of the rice in Washington County.

AUSTIN COUNTY.

In Austin County there are a few well plants. That of Hackborth & Koy is on Mill Creek, from which it takes its water, 6 miles northeast of Sealy. It consists of an 8-inch Morris pump and a 40-horsepower Erie City engine, working against a lift of 31 feet. The soil is described as a red buckshot with an admixture of black sand. Two hundred acres were irrigated during 1902.

SAN BERNARD CREEK.

Stone system.—On East San Bernard Creek James and Stephen Stone have installed an irrigation system 1½ miles from Beard, with which 390 acres were irrigated in 1900, producing, after the Galveston storm, 6 sacks to the acre, commanding $3 a sack, and 300 acres in 1901, yielding 3,000 sacks, which sold for $3 a sack. The plant con-

sists of one 150-horsepower Westinghouse automatic compound engine, operating a No. 13 Ivens pump having 15-inch suction and 13-inch discharge pipes. The estimated capacity is 7,000 gallons a minute (16 second-feet) under a lift of 27 feet. The flume is 5 feet by 2 feet by 520 feet long, and delivers the water into a canal 2 miles long and 100 feet wide. The laterals are three-fourths mile long and 15 feet wide. The soil is light and sandy, from 1 to 1½ feet deep. Wood is used for fuel, requiring 3 cords a day for the 390 acres irrigated in 1900. The experience here in 1900 confirms the estimate of irrigators in the Beaumont section and in western Louisiana—that it requires fully 9 gallons a minute for each acre irrigated, or 1 second-foot for each 50 acres. In 1902 300 acres were irrigated.

Jahn system.—Just north of Beard G. A. Jahn and associates have opened up a rice farm with the intention of deriving the necessary water from San Bernard Creek by impounding in a reservoir of 100,000 gallons' capacity.

A crib-work dam, 350 feet long, backs the water up 1 mile and deflects it into a canal and pit. The water is then pumped, under a lift of 25 feet, into a reservoir covering 180 acres. The water is pumped out of the reservoir into the supply canals by two 18-inch Van Wie pumps. The power is supplied by a 300-horsepower Corliss engine. This company irrigated 700 acres in 1902. Ten miles southeast of Sealy, and 4 miles north of Chesterville, Dr. Magruder has constructed a dam across the Little Bernard, forming an impounding reservoir from which, with a 28-horsepower engine, he pumped water into 75 acres of rice during the season of 1902. Adjoining the San Bernardo Company, Stephen Stone has dammed a small tributary of the San Bernard, forming an impounding reservoir from which, with a 150-horsepower Westinghouse automatic compound engine and one 13-inch Ivens centrifugal pump, he raises the water into his flumes. In 1902 300 acres were thus irrigated.

FORT BEND COUNTY.

The Fort Bend Irrigation Canal Company has two pumping plants. The second plant pumps from Smithers Lake, which during average seasons has an abundance of water for ordinary purposes. The lake has a drainage area of 14 square miles, and the outlets are dammed to prevent waste. Notwithstanding this, it was evident early in the season of 1901 that the long-continued drought in the coast country, which extended practically from September 8, 1900, to September, 1901, had completely exhausted the resources of the lake. At the second lift the plant is composed of one 50-horsepower Chandler & Taylor engine and one 13-inch Ivens pump, the capacity of which, with the lift of 18 feet, is estimated to be 10,000 minute-gallons. The soil is black prairie land with a good subsoil, 400 acres of which were irrigated during the current season. The plant at the river consists

of an engine of 250-horsepower, operating the pump against a lift of 45 feet. This plant pumps the water into Dry Bayou, and this in turn to Lake Bayou. A dam has been constructed across Rabb Bayou to hold the water from passing out. The acreage in 1902 was 750.

The pumping plant of the Brazos Canal Company is located on Jones Creek, 5 miles north of Richmond, Tex., and 30 miles west of Houston. The water is taken from the creek, which possesses the characteristics of a bayou and acts as a storage reservoir 17 miles long. The lands to be irrigated lie to the west of Houston and fall generally to the eastward from the pumping plant. An extra pumping plant is located on the Brazos River just below the upper junction of Jones Creek with the Brazos, and at low stages the river pumps will have to lift the water 32 feet into the reservoir. A tunnel is excavated from the bayou reservoir to the river, and when the level of the river water rises 32 feet it flows into the reservoir without pumping or it can be shut off if desired. At the second pumping plant the water will be lifted 52 feet into a canal, giving 4 feet of water in the canal, which, with the configuration of the country, can cover the lands to the east by gravity. During 1902 it is intended to irrigate 2,000 acres only.

The Brazoria Rice and Irrigation Company takes its water from the Brazos above a crossing of the Santa Fe with the Brazos. The plant consists of a 900-horsepower Greenwald engine, operating a Worthington high-lift 36-inch pump against a head of 47 feet, and has an estimated capacity of 35,000 minute-gallons. The 100-foot canal from the river conveys the water into a lake of 27 acres about 1½ miles from the river. The water is pumped out of the lake into the second canal by a 450-horsepower Greenwald engine and a 36-inch Worthington pump against a lift of 17 feet. The canals extend at present to the eastward, crossing the tracks of the Columbia Tap Railroad near Riceton. It is contemplated to construct another canal crossing the Santa Fe Railroad and irrigating land south of Arcola Junction. Only 4,800 acres were irrigated by this company in 1902.

BRAZORIA COUNTY.

In Brazoria County the following persons have plants: J. A. Bent, William Masterson, Howard F. Smith, Rod Oliver, H. and G. Munson, F. C. Baker, Judge Walker, A. H. Bartel, and John Chase. Two miles south of Arcola Junction, J. A. Bent has a small plant of about 35 acres, where a small donkey engine and a 4-inch Morris pump raise the required water from a well. The rice farm of William T. Masterson is 4 miles southwest of Sandy Point, and derives its water from Oyster Creek. A 25-horsepower Erie City engine operates an 8-inch Morris pump against a lift of 17 feet and irrigates 30 acres of rice, yielding 250 sacks. H. F. Smith's farm of 175 acres is 1½ miles north of Sandy Point, and derives its water from Jackson Lake.

The plant of Rod Oliver is 10 miles southwest of Angleton. A 25-horsepower engine operates a special pump designed by Mr. Baker, of Angleton, against a lift of 10 feet. It discharges through a vertical penstock 3 feet by 3 feet. Seventy-five acres were irrigated in 1901. The plant of H. and G. Munson is 3 miles west of Angleton, on Oyster Creek, and consists of an 80-horsepower Erie City engine, operating a 15-inch Morris pump, against a lift of 10 feet. This plant was late in being completed, but notwithstanding this 250 acres were irrigated in 1901. Only 100 acres were harvested, however, the yield being 900 sacks, which sold for $2.50 a sack. In 1902 700 acres were irrigated.

The rice farm of Walker & Cain, near Angleton, has three pumping plants. The first is located on Bastrop Bayou and consists of one 150-horsepower engine, operating two 15-inch centrifugal pumps against a lift of 10 feet and having an estimated capacity of 25,000 minute-gallons. The second plant is located on Oyster Creek and constitutes an emergency plant in times of low water in Bastrop Bayou. One 125-horsepower engine pumps the water from Oyster Creek into the canal that leads to Bastrop Bayou. A dam has been constructed across Bastrop Bayou to keep back the salt water, but it also acts as a storage reservoir for the fresh water. Plant No. 3 constitutes the second lift for the main supply canal. It is 2 miles from plant No. 1, and a 75-horsepower engine operates the pumps against a lift of 6 feet and has an estimated capacity of 15,000 minute-gallons. In 1902 1,400 acres were sown.

John Chase also obtains water for his 60 acres of rice from the Bastrop Bayou, 6 miles southwest of Angleton. He harvested only 75 acres in 1901. The pump used is of a special make, manufactured by Mr. Baker, of Angleton. It is run by a 25-horsepower Erie engine and operates under a lift of 8 feet. The crop was badly injured by salt water, the yield being 2 sacks to the acre.

J. G. Smith & Bro. own and operate two rice farms, one 6 miles north and the other 9 miles west of Columbia. The first derives its water from a lake covering 2,000 acres, but the lake failed and the result was no crop. The plant is composed of two Atlas engines of 40 and 25 horsepower and two Morris pumps, one 15-inch and the other 12-inch. The lift is 12 feet and the estimated capacity 6,200 gallons a minute. The plant was first operated in 1900, when 85 acres of rice were raised; but in 1902 the acreage was expanded to 550 acres. The second plant (9 miles west of Columbia) is to derive its water from an 8-inch well 270 feet deep, but it was not completed in time for the 1901 crop. One 40-horsepower Nagle engine runs an 8-inch Morris pump, working under a lift of 10 feet. The soil is a black, waxy prairie soil. This firm also operates a well plant of 60 acres near Guy, in the Fort Bend country.

The plant of A. H. Bartel is 6 miles from Angleton, on the Bastrop

Bayou, and consists of a 25-horsepower engine and a 12-inch Lawrence pump, operating against a lift of 8½ feet. He irrigated 75 acres in 1901, the yield being 135 sacks. In 1902 100 acres were irrigated.

COLORADO VALLEY SECTION.

The principal rice irrigation systems of the Colorado Valley are in Colorado, Wharton, and Matagorda counties. The larger systems are indicated on the map forming fig. 24.

COLORADO COUNTY.

EAGLE LAKE.

Dunovant system.—In 1899 Capt. William Dunovant irrigated 250 acres of rice near the town of Eagle Lake. This was the first rice farm irrigated along Colorado River, and proved so successful that in 1900, 30,000 acres were irrigated in the Colorado Valley, and in 1901 56,000 acres. Water for the Dunovant plant is pumped from Eagle Lake, a beautiful, clear, fresh-water lake near the town of the same name, covering an area of about 2,500 acres and having an average depth of 8 feet. This was the first time the waters of the lake were utilized for irrigation purposes. Captain Dunovant's plant originally consisted of a 12-inch Van Wie double-suction pump, throwing 4,000 gallons a minute. The lift was 27 feet. The three boilers were old-style tubular, which were moved from a sugar mill that had been destroyed by fire. Two had two 14-inch and two 10-inch flues, and the third had two 16-inch and two 10-inch flues. The engine was a 200 horsepower. The flume, which was made of piping, had a length of about 350 feet. With this equipment 250 acres were irrigated in 1899. The plant was added to considerably in 1900. A new 21-inch Ivens pump, having a capacity of 15,000 gallons, and a 150-horsepower automatic engine were installed, and with the other operating machinery 3,000 acres were irrigated. In 1902, 3,600 acres were irrigated.

As Eagle Lake will not supply this plant and that of the Eagle Lake Rice Company, Captain Dunovant and the rice company have each erected pumping plants on Colorado River to pump water from the river to the lake.

The plant has been added to from time to time till it now consists of three pumping stations, two on the lake and one on the river. That on the river consists of a 300-horsepower engine, operating three centrifugal pumps—one 18-inch Morris, one 15-inch Morris, and one 18-inch Ivens—all working under an ordinary lift of 14 feet. The lift would have been much more than this, but the canal to convey the water from the river to the lake was so deepened that the low lift of 14 feet was secured. The old plant on the lake consists of three engines—two of 150 horsepower each and one of 60 horsepower. These operate, against a lift of 22 feet, three centrifugal pumps—one 12-inch Van Wie, one 20-inch Morris, and one 21-inch Ivens. This plant

delivers the water into a flume that connects with the main canal system that crosses the tracks of the Cane Belt Railroad by means of an inverted siphon. The third plant is situated on the lake between the towns of Lakeside and Eagle Lake and is operated by an electric motor that derives its power from the engines at the gin in Lakeside. The pump is a 12-inch Morris and works under a lift of 27 feet. The water is delivered into a flume which connects with a main canal that

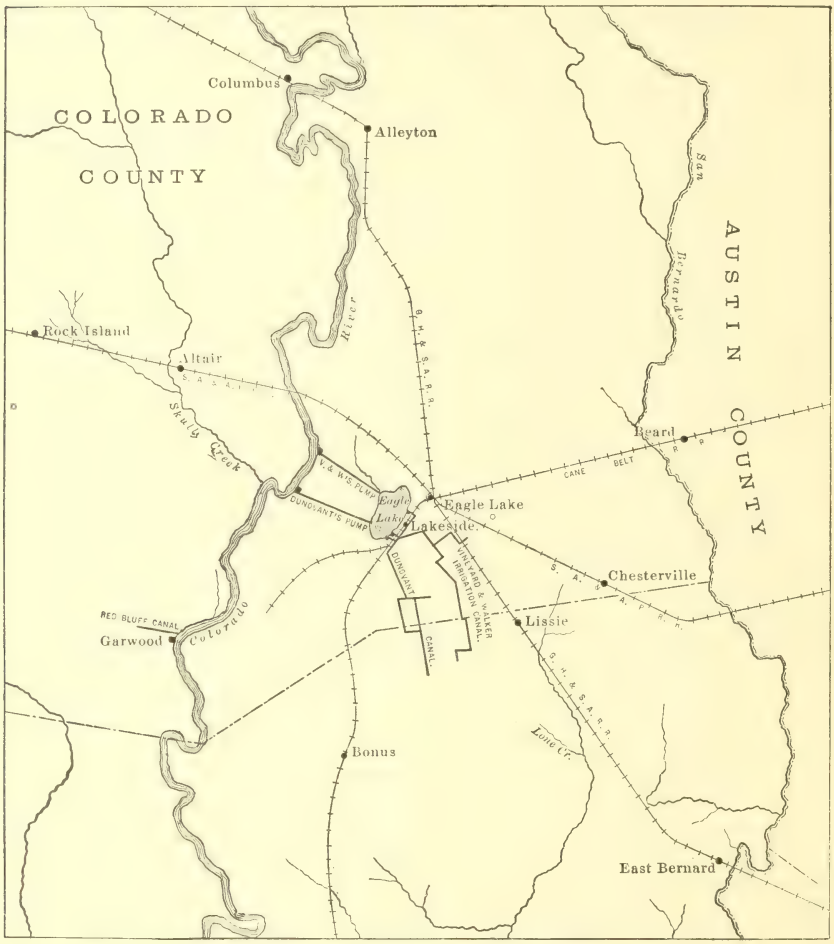


FIG. 24.—Map showing irrigation canals at Eagle Lake.

also crosses the Cane Belt tracks and there parallels the tracks crossing the canal of the Eagle Lake Rice Company's plant and connects with the canal from the original pumping stations. At these stations 80 barrels of Beaumont oil are used for fuel every twenty-four hours. In 1902 3,600 acres were irrigated.

The Eagle Lake Rice Company system (also known as Vineyard and Walker Canal).—This company has erected a pumping plant

about one-fourth of a mile north of Captain Dunovant's, on the eastern edge of Eagle Lake, and another on Colorado River, 3 miles from the first plant. The plant on the lake consists of three 125-horsepower boilers and one 250-horsepower engine, operating a 24-inch Ivens pump having a capacity of 20,000 gallons a minute, and one 350-horsepower engine, operating a 30-inch Ivens pump having a capacity of 25,000 gallons a minute. Either of the pumps can be operated from the boilers, but both can not be operated at the same time. This plant is equipped with oil burners and storage tanks and a pipe line from the Cane Belt Railroad. The river plant consists of one 300-horsepower engine and two 150-horsepower boilers (another of the same size is being added), operating a 30-inch Ivens pump of 25,000 gallons capacity, against a maximum lift of 28 feet. The water is canalled to a branch, which takes it into the lake, and from there, in time of low water, is conveyed by means of a canal to the plant across the lake. The river plant has a 3-inch oil-pipe line 7,000 feet long leading from the Aransas Pass Railroad to the plant, also storage tanks, and is fully equipped for burning oil, which has proved a very satisfactory fuel in every way. It is cheaper in first cost, can be applied at less than half the expense for firemen, and is more effective than coal or wood.

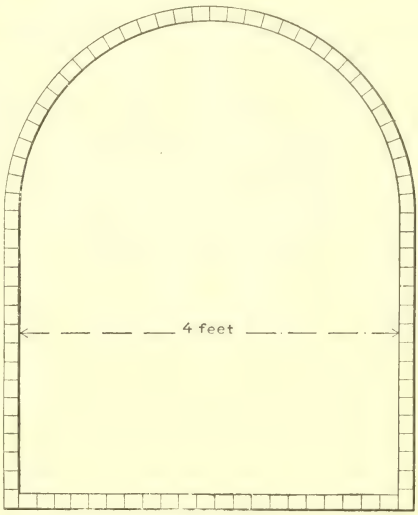


FIG. 25.—Cross section of Eagle Lake Rice Company's siphon under Cane Belt Railroad.

The canal is 60 feet wide at its head, or where the flume enters it, but after the rice farm is reached the width is increased to 100 feet. The total length of the canal is 16,840 feet. The distance from the mouth of the canal to the first gate is 4,300 feet. There are two large laterals leading from the canal, one 4,000 feet long, the other 3,000 feet long. A few hundred feet from its head the canal crosses the Cane Belt Railroad, and this crossing led to a dispute between the canal company and the railroad company. The canal was too high to go under the railroad as graded, and the company would not elevate the track so that the canal could go under. It was finally decided to carry the water under the track by a siphon. This siphon, except under the track proper, is made of brick, the cross sections and dimensions being shown in fig. 25. Owing to the jar caused by passing trains it was considered wise not to extend the brick conduit under the track. Consequently the brickwork stops on both sides, just

before the track is reached, and the water is carried through by means of pipes. The falling and rising curves in the siphon are easy, so as to eliminate as much friction as possible.

The company irrigated 3,000 acres in 1900. In 1901, 3,200 acres were planted, but the supply of water in Eagle Lake failed to such an extent that only a few acres were harvested. It is the intention to sow from 3,000 to 3,500 acres in 1902. The soil on the farm is black and sandy. The contour of the land proves to be of great advantage, for after a certain distance the ground falls, making a second lift plant unnecessary.

COLORADO RIVER.

Sigler system and Harbart-Stafford Rice Company systems.—West of Colorado River, near the stations of Altair and Rock Island, on the San Antonio and Aransas Pass Railroad, several small rice irrigation plants have been introduced. On the west bank of the river a few hundred feet below the railroad bridge, in plain view of passing trains, are the pumping plants of Dr. H. C. Sigler and the Harbart-Stafford Rice Company. The rice farm of the former, which is nearest the railroad bridge, lies along both sides of the railroad track. The plant consists of an 8-inch Wells pump operated by a 35-horsepower Atlas engine. Under a lift of 34 feet the capacity of the plant is estimated at 2,500 gallons a minute (42 second-feet). The plant cost $4,500, and from it 200 acres of rice were irrigated in 1900 (producing 2,500 sacks) and 200 acres in 1902.

The plant of the Harbart-Stafford Rice Company is just below that of Dr. Sigler and west of Colorado River. It consists of a 150-horsepower Atlas engine operating an 18-inch Van Wie suction pump having an estimated capacity of 16,000 gallons a minute (35 second-feet) under a lift of 33 feet from the river level to the flume. The flume is 200 feet long, 5 feet wide, and 2 feet deep, and discharges into the main canal, which is 1½ miles long and 40 feet wide, with 2 miles of laterals 20 feet wide. The plant cost $8,000, and the company planted 350 acres of rice in 1902.

Westmoreland system.—Four miles from the Aransas Pass Railroad bridge J. W. Westmoreland has a rice farm of 225 acres. The water is taken from Colorado River by an 8-inch Morris vertical suction pump. The engine is a 50-horsepower Erie City, and the water is raised to a height of 42 feet.

Four miles east of Rock Island and 1 mile below the crossing of the San Antonio and Aransas Pass Railroad with Skull Creek the Brandon Brothers have a rice farm that derives the necessary water from Skull Creek. The plant consists of a 40-horsepower Erie City engine and an 8-inch Van Wie pump that operates against a lift of 32 feet, and during the season of 1902 irrigated 85 acres of rice.

The total rice acreage in Colorado County west of the river is as follows: From well plants, 840 acres; Brandon Brothers, 85 acres;

J. W. Westmoreland, 220 acres; H. C. Sigler, 150 acres; Harbart-Stafford, 350 acres; Red Bluff Company, 1,200 acres; total, 2,845 acres.

WELL PLANTS.

On the west side of the Colorado River, in the country lying between Rock Island and Garwood, a number of small rice farms that derive their water from wells have been opened up. The wells are somewhat similar in construction and always consist of a pit, either circular or rectangular in cross section, excavated to a depth of 18 to 22 feet, with a bored well in the bottom. This well must always extend through sufficient water-bearing sand and gravel to give flow enough for the farm. A screen must be let into the sand strata, which will keep the sand as far as possible out of the pipes and will admit sufficient water. These screens are of various forms and lengths, and upon the screens often hangs the success of the whole enterprise. The first step in a scheme of this kind is to get a well. Nothing further should be done till the well is an assured fact. The screen can be of side or end suction. In the former case the pipe is perforated with holes one-half to three-fourths inch in diameter, 2 to 3 inches apart. Around the pipe is then wrapped fine wire, almost touching, and over this a copper gauze is stretched, the mesh varying with the kind of sand, and often experience is the only sure test. The end-suction screen will be described later. The wells of Baker Brothers and W. C. Jones will serve to illustrate those west of the river in Colorado County. The Baker well has a screen 27 feet long at the bottom of a 67-foot well, while the Jones well encountered water at a depth of 34 feet, and from this depth was placed a 30-inch screen 29 feet through coarse gravel. The suction pipe is attached to the screen pipe, and generally a centrifugal pump is placed in the bottom of the pit, and the vertical shaft extends several feet above the surface of the ground. A pulley is mounted on this shaft and is operated from the engines by belts. The engines are generally, for a single well, small steam engines of 15 to 40 horsepower, or gasoline engines of 12 to 28 horsepower. A good well outfit ought to be put in for about $1,600. The well plants west of the river in Colorado County are as follows: Frank Marshall, 50 acres; Berry Brothers, 90 acres; E. D. Bone, 135 acres; W. C. Jones, 200 acres; John Duncan, 100 acres; Baker Brothers, 100 acres; Berry, Cox, Johnson, 85 acres; Will Carr, 80 acres; total, 840 acres.

Just north of Garwood the plant of the Red Bluff Rice Company takes its water from the Colorado River. The plant consists of two 150-horsepower Erie City boilers and one 300-horsepower Corliss engine. Water is pumped from the Colorado River, and 1,200 acres of rice were irrigated in 1902. The lift is 42 feet and the pump is an 18-inch Morris centrifugal and has an estimated capacity of 15,000

minute-gallons. The water is delivered into a flume 600 feet long and then into the main canal, which is 100 feet center to center of embankments and 1½ miles long. The laterals are about 30 feet center to center of embankments and about 1 mile long.

Marshall system.—Within the neighborhood of Rock Island, on the Aransas Pass Railroad, there are a number of projected rice farms and a few that were ready at the opening of the season of 1901. Two miles south of Rock Island, Frank Marshall has a well 78 feet deep, from which water is forced by a 6-inch Morris pump operated by a 35-horsepower Erie City engine. The plant cost $1,500, and although it was late in the season before it was ready for work, 100 acres were irrigated in 1901.

Small system.—Nine miles south of Rock Island, A. W. Small owns a plant consisting of a 6-inch Morris pump and a 35-horsepower Erie City engine. The lift is 40 feet, and the plant is estimated to possess a capacity of 1,050 gallons a minute. Ninety acres were irrigated in 1901. The cost of the plant was about $1,600.

In that section lying east of the Cane Belt Railroad and between Sealy, Hungerford, and East Bernard there are twenty well plants, averaging two wells to the plant, the acreage varying from 75 to 550. These plants, lying mostly in that section bounded by Eagle Lake, East Bernard, and Chesterville, have a common bond, in that they obtain their water from the water-bearing sand lying under the upper, blacker soil. A few typical plants will be described.

Vick system.—About 2 miles east of Eagle Lake, George Vick has installed a plant to irrigate from wells. In 1900 he sunk a well 12 feet in diameter and 34 feet deep, and with an Ivens submerged pump discharging through a 5-inch force main he irrigated 125 acres of rice. The pump was operated by an Avery traction engine, which is also used for traction purposes. The water was discharged into a small flume 12 inches by 12 inches, which in turn discharged into a ditch 25 feet wide and 1 mile long. In addition to the 125 acres irrigated from the pumps, 25 acres were irrigated by damming a small stream and forming a storage reservoir. In 1900 Mr. Vick sowed 1½ bushels to the acre, but increased this to 1¾ and 2 bushels an acre in 1901. The crop of 1900 was damaged by the Galveston storm, but notwithstanding this he realized 19 bushels to the acre, which sold for from $1.50 to $4.25 a sack. The total cost of the plant used in 1900 was $2,250. This plant is now owned and run by Hudson & Ayres. A new 45-horsepower Erie City engine has replaced the traction engine. Beaumont oil is used as fuel, and it requires about 3 barrels for a a twenty-four-hour run. In 1902 165 acres were irrigated.

Adams system.—The feasibility of using windmills for rice irrigation was thoroughly tested at the farm of Adam Adams, 4½ miles east of Eagle Lake. He installed nine Gamble long-stroke wind-

mills, each having a 3-inch by 14-inch cylinder and a 10-foot wheel, operating pumps having 2-inch suction and discharge pipes against a lift of 25 feet from the seven wells that furnish the water. The plant cost $825. The water is discharged into a reservoir 4 feet deep covering 15 acres and having a capacity of 174,240 cubic feet. It is estimated that the windmills have a capacity of 70 gallons a minute.

The windmills proved insufficient, and they have been abandoned. A Fairbanks-Morse 22-horsepower gasoline engine, operating a 6-inch Morris centrifugal pump, is now used to raise the water to the flume. Eighty acres were irrigated in 1902.

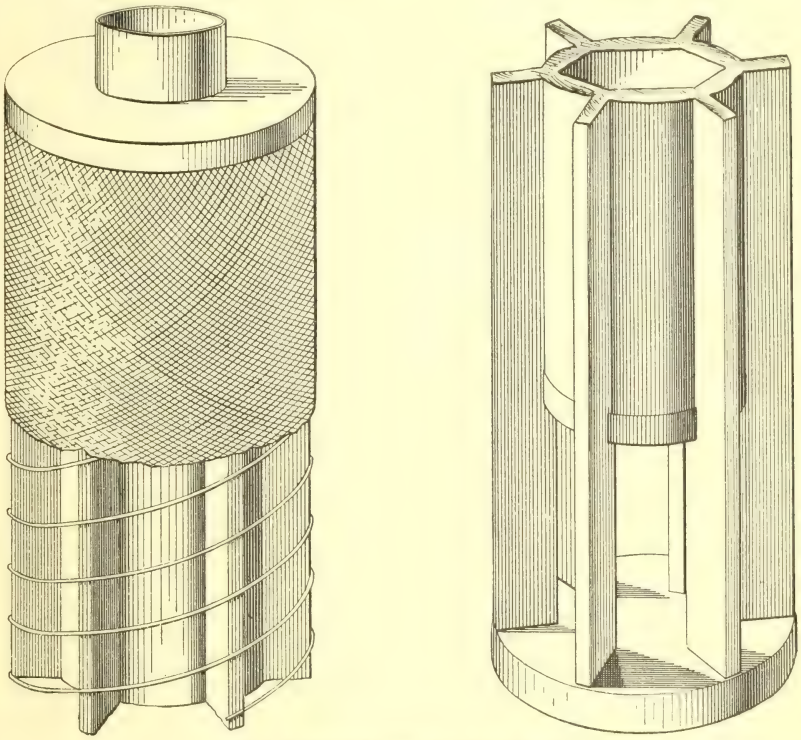


FIG. 26. Sand screen for water wells.

A typical surface well for the Chesterville plants would be 41 to 44 feet deep, 19 feet to water-bearing sand, and then 20 to 25 feet of sand, followed by clay. A very successful screen with bottom suction 8 feet long is used in this neighborhood. It consists of a wooden pipe about 8 inches in diameter, from which 6 to 8 radial vanes project about 6 inches. A heavy wire is wrapped spirally around the vanes, making another cylinder, varying in diameter from 24 to 36 inches. Around the wrapped cylinder on top of the wire is attached a wire gauze with a mesh of 24 to the inch, which holds back the sand, permitting the water to enter. The vanes extend below the bottom

of the pipe and are attached to a bottom cap, thus leaving an open space for the water to enter the bottom of the central wooden cylinder. The suction pipe of the pump is attached to the wooden cylinder near the top of the screen. A good well and a good screen are the sine qua non for a successful well plant. All failures can be traced to their absence. This is the reason that active plants of 1901 are idle in 1902. They constitute the foundation stone of success in the prairie rice farm. Without them the biggest pumps in the State could not raise water. Many plants in Texas in the last two years have been started at the wrong end. Elaborate canals, excellent machinery, fine, black, hog-wallow land are futile without sufficient water of the right kind. At plant No. 2 of John Linderholm, at Chesterville, 1,350 acres of rice were irrigated in 1901, although a late start was made. The machinery consists of a 28-horsepower gasoline engine, operating a 6-inch Van Wie pump. The plant cost $2,150; expenses, $500; and the crop paid for the plant, expenses, and the land, estimated at $12.50 per acre. This season Watt's refined Beaumont oil is used as a fuel in the gasoline engines.

Foster system.—In the neighborhood of Chesterville, 7 miles east of Eagle Lake, H. L. Foster has installed a plant to derive its water from a well. One 20-horsepower Erie engine runs a No. 4 Morris pump having 5-inch suction and 4-inch discharge, which has an estimated maximum capacity of 600 gallons a minute (1.33 second-feet) against a head of 21 feet. The canals are three-eighths mile long and 6 feet wide. Unfortunately the water supply proved a failure, and additional wells will have to be dug to obtain sufficient water for the rice land.

Linderholm system.—One-fourth mile from Chesterville, John Linderholm has three of the most effective well plants in Texas. Three No. 6 Van Wie pumps, having 8-inch suction and 6-inch discharge, and one No. 3 Van Wie pump, having 5-inch suction and 3-inch discharge, are operated by four Fairbanks & Morse engines of 34, 28, 34, and 12 horsepower, respectively, against a lift of 20 feet, estimated to have a capacity of 8,000 gallons a minute (18 second-feet). The wells are on the highest points of the land, and no flumes are necessary. Two reservoirs have been constructed, but so far they have not been utilized. The soil is a sandy loam, and the 125 acres irrigated in 1900, notwithstanding the Galveston storm, produced 8 sacks of rice to the acre, commanding $3.50 per barrel of 162 pounds. Four hundred acres were irrigated in 1901, the yield being 9½ sacks to the acre, commanding from $3 to $3.10 a barrel. Land is rented on the usual one-half plan, i. e., one-fifth of the crop for land, one-fifth for water, and one-tenth for seed. Gasoline is used as fuel. The engines are run twelve hours a day, and require 2,592 gallons of gasoline (74 per cent proof) daily, or 2 gallons per hour per horsepower. The three plants watered 550 acres in 1902.

Gray system.—Near Lissie, George Gray has installed a 28-horse-

power Fairbanks & Morse gasoline engine, which operates a Van Wie pump having a 6-inch discharge pipe and an estimated capacity of 22,000 gallons a minute (5 second-feet). The plant cost $1,500. The water is supplied by two wells, one an 8-inch well 103 feet deep, with 91 feet of water, the other a 10-inch well 140 feet deep, with 115 feet of water. The main canal is three-fourths mile long and 8 feet wide. The soil is black and sandy, with a clay subsoil. One and one-fourth bushels of rice are sowed to the acre. For the land rented one-fifth of the crop is charged for land rent, one-fifth for water, and one-tenth for seed—i. e., for land, water, and seed, one-half of the crop is charged. In all 120 acres were irrigated in 1901, but the cold weather ruined 50 acres. The 70 acres saved yielded 740 sacks. A second plant has been added, and 400 acres were planted in 1902.

Malmquist system.—C. T. Malmquist irrigated 38 acres from one well by an 8-horsepower Fairbanks & Morse gasoline engine, operating one No. 4 Ivens pump having 5-inch suction and 4-inch discharge pipes, and an estimated capacity of 600 gallons a minute (1.33 second-feet) under a lift of 16 feet. The plant is 1 mile from Chesterville. The yield was 300 sacks, which sold for $3.15 a sack.

McLain system.—Four and one-half miles from Chesterville George McLain irrigates 160 acres from two wells. One Charter 18-horsepower gasoline engine runs a No. 4 Van Wie pump having a 5-inch suction and a 4¼-inch discharge. The plant has an estimated capacity of 1,200 gallons a minute (2.67 second-feet) under a head of 15 feet. Only 5 acres were planted in 1900, and the crop was considerably damaged by the Galveston storm. The soil is black and waxy, and produced 7 sacks to the acre in 1900. The water supply failed in 1901, and Mr. McLain raised no rice.

Townley system.—The plant of J. C. Townley, three-fourths mile from Chesterville, consists of one No. 8 Morris pump having 9-inch suction and 8-inch discharge, operated by a 35-horsepower Erie City engine. The lift is 20 feet and the estimated capacity 1,700 gallons a minute (3.8 second-feet). The soil is black and sandy. Two hundred acres were irrigated in 1901. The plant, exclusive of land, cost $3,000.

Electric system.—Instead of having several distinct power plants, each to carry its own pump and acreage, the Bernard Rice and Irrigation Company (C. B. Sloat, manager) has erected on its plant, 2 miles east of Lissie, a central power plant, consisting of a steam engine and boiler of capacity sufficient to carry two whole pumping plants. The power is conveyed to a 75-kilowatt electric motor, and by this the power is transmitted electrically by wire to smaller motors of 20-horsepower capacity at the three pumping plants on the farm. The experiment will demonstrate clearly the most economical method of operating plants where pumps are located in different parts of the farm.

WHARTON COUNTY.

Hudgins Brothers system.—Seven miles east of Wharton the Hudgins Brothers have opened up a large rice farm and are giving wells a full and fair test. They have in all eleven wells; seven are 44 feet deep and four are 36 feet deep. The pumps are about 13 feet below the surface. There are ten No. 3 and one No. 1 Van Wie rotary pumps. The former cost, exclusive of freight, $85 each, the latter $115. The pumps are operated by gasoline engines, five of 22 horsepower and one of 16 horsepower. Eleven hundred acres of Japan rice were irrigated in 1901, but only 450 in 1902.

The acreage from well systems in the section between Sealy and Hungerford is shown in the following: Hudson & Ayers, 165 acres; W. W. Miller, 200; R. B. Dobbins, 100; J. E. Irvin, 40; Adam Adams, 80; John Linderholm, 550; J. C. Townley, 200; C. T. Malmquist, 60; W. S. Strickland, 100; George McLain, 150; George Gray, 400; Bernard Rice Company, 205; H. Cordz, 300; Paul Jackets, 80; McBride & Lester, 100; W. S. Moore, 100; L. Pietsch, 170; Longworth & Caylor, 300; Hudgins Brothers, 450; J. M. Everett, 140; total, 3,890 acres.

EL CAMPO SYSTEMS.

In the section of Wharton County west of the Colorado River, along the line of the New York, Texas and Mexican Railroad, near the stations of Pierce, El Campo, and Louise, more well plants are in operation than in any other section of Texas. Two systems of wells are used, the shallow and the deep. The shallow wells are all of one general type. A pit, rectangular or circular in cross section, is excavated to the depth to which the water will rise, and in the bottom of the pit one or more wells are bored through or into the water-bearing sand or gravel. In this is placed the screen. The pits vary in depth from 10 to 19 feet, and the wells from 40 to 70 feet. The soil is generally black and sandy, underlain by clay, which lies over the water-bearing sand. The Milner well, a mile west of Pierce, will serve as a type for the deep wells. This well is 180 feet deep, 10-inch bore, and has 60 feet of screen. The log shows 14 feet of black soil, thick stratum of red clay, 6 feet of quicksand, 4 feet of clay, 16 feet of coarse sand and gravel, and three thin layers of clay alternating with thicker strata of sand and gravel. This well and its companion shallow well (both in the same pit) constitute in their combined capacity by far the best well found in the Texas rice belt. One of the best shallow-well plants found in this section is that of Fred Blumquist, 1½ miles east of El Campo, which is described later.

A few typical plants are here described.

Brunes system.—The plant of Chris. Brunes is just east of the Beard plant. It consists of a 5-inch Morris pump operated by a 20-horsepower Advance traction engine. The well is 48 feet deep, the water rising to within 19 feet of the surface. The head is 24 feet

and the capacity estimated at 800 gallons a minute. The engines, pumps, belts, etc., cost $1,500. Fifty acres were irrigated in 1901, yielding 785 sacks, commanding $3.10 a sack.

Nordin system.—P. H. Nordin's plant is 2 miles north of El Campo. The well is 48 feet deep, the water being 20 feet below the surface. He uses a 20-horsepower J. I. Case traction engine and a 6-inch horizontal centrifugal pump. The capacity is estimated to be 700 gallons a minute under a head of 21 feet. The engine and pumps cost $1,350. Fifty acres were irrigated in 1901, yielding 413 sacks.

Just east of this plant is the plant of J. B. Carlson, which irrigated 50 acres of rice in 1900, the yield being 350 sacks. The pit of the well is 8 feet in diameter and 25 feet deep; the bored part of the well is 27 feet, making a total depth of 52 feet. The pump, a 6-inch Van Wie, is in the bottom of the pit, and has a lift of 26 feet. It is operated by a 16-horsepower Fairbanks & Morse gasoline engine. A test made at this plant shows that it requires 46 gallins of gasoline each twenty-four hours, or nearly 3 gallons to the horsepower. In carload lots the gasoline costs 12 cents a gallon, delivered at El Campo.

A second pumping plant run by a traction engine is conducted by Mr. Carlson.

Olesen system.—Five miles north of El Campo is the rice farm of D. Olesen. The well is 52 feet deep, 7 feet in diameter for 25 feet and bored the rest of the way. As at all of these plants, the water is pure, fresh, and as clear as crystal. The plant consists of a 5-inch Morris vertical pump and a 20-horsepower Advance compound traction engine, and cost $1,500. The pumps are 22 feet below the surface of the ground, giving a lift of 27 feet. The estimated capacity is 750 gallons a minute. Thirty acres were watered in 1901, the yield being 150 sacks.

Higbee system.—In 1901 R. E. Higbee irrigated 98 acres of Honduras rice, the yield being 1,500 sacks. The soil is a black hog-wallow. The well is 48 feet deep, the water rising to within 13 feet of the surface. The plant is 1 mile east of El Campo and consists of a 6-inch Van Wie pump and a 25-horsepower J. I. Case engine. The lift is 17 feet, and the capacity estimated at from 1,200 to 1,500 gallons a minute.

Berglund system.—P. E. Berglund uses a 35-horsepower Weber gasoline engine and a 6-inch pump. His well is 34 feet deep, the water level being 12 feet below the surface. The rice is sowed with a seeder attached to the hind gate of a wagon. Thirty-five acres were irrigated in 1901, the yield being 450 sacks.

Blumquist system.—One and one-half miles east of El Campo Fred Blumquist irrigates 35 acres, the yield in 1901 being 741 sacks, 4 bushels to the sack. He sold part for seed rice at $3.25 to $3.50 a sack. His pumps are in a pit 8 feet by 10 feet. The well is bored in the bottom of the pit to a depth of 30 feet, making the total depth of well 40 feet. The pump is a 5-inch Morris horizontal rotary working under a lift of

15 feet, and the engine a 14-horsepower Foos gasoline. The cost of all was $970.

Danielsen system.—The pump, lift, and engine of A. Danielsen are similar in all respects to those of Blumquist. Sixty acres were irrigated in 1902, yielding 700 sacks, which sold for $3 a sack.

Embry system.—The farm of J. R. Embry is 4½ miles east of El Campo. The soil is a black hog-wallow. Ninety acres of rice were irrigated in 1901, yielding 625 sacks. The pit is 4 feet by 16 feet by 6 feet deep. Two 8-inch wells were bored in the pit to a depth of 34 feet, making a total depth of 40 feet. The water rises to the bottom of the pit. An 18-horsepower gasoline engine runs the 6-inch Morris horizontal rotary pump against a lift of 8 feet.

Schult system.—Six miles east of El Campo Oscar Shult has opened up a rice farm on which 100 acres of rice were irrigated in 1901, the yield being 858 sacks. The source of water is a well 39 feet deep. The pit is 8 feet by 9 feet by 9½ feet deep. The bored part (30 feet) is 14 inches clear diameter. The machinery consists of an 18-horsepower gasoline engine and a 6-inch Morris horizontal rotary pump. The soil is a black hog-wallow, and both the Honduras and the Japan rice will be tried. Fifty-five pounds of Japan (1⅓ bushels) and 1½ bushels of Honduras were sowed to the acre.

The well camps around El Campo are all similar, the greatest variation being in the machinery of operation. No attempt is made to give the individual peculiarities of each plant, as a few typical plants cover the essential features. The extent of the well system tributary to El Campo and Pierce is shown by the following list: O. R. Johnson, 153 acres; Oscar Nelson, 60; A. Danielsen, 80; Fred Blumquist, 120; A. P. Olesen, 60; R. E. Higbee, 70; N. Thompson, 200; A. Burglund, 50; T. Rolf, 40; Axel Bard, 60; J. W. Leech, 160; W. H. Waugh, 100; J. R. Embry, 75; Johnson & Jensen, 70; Oscar Schult, 250; James Milner, 750; P. A. E. Nelson, 50; A. P. Borden, 50; N. J. Sunwall, 50; M. Barnhardt, 25; A. P. Borden, 50; W. S. Wood & Co., 300; Chris Brunes, 105; P. H. Nordin, 105; Boehm Brothers, 60; J. B. Carlson, 175; Nelson Brothers, 200; Fritz Bender, 60; A. E. Carlson, 75; Woolsey, 120; A. S. Thompson, 75; O. B. Scroggins, 50; W. S. Louis, 75; E. G. Sterner, 150; L. Cahn, 60; John Bacek, 30; William Neizer, 50; Frank Garetzky, 50; John Wetzel, 50; T. A. Hill, 120; total, 4,200 acres.

Louise systems.—Near Louise station, on the Texas Mexican Railroad, over 1,200 acres of rice were sowed in 1902, but of the seven plants only two had sufficient water. A successful typical well here has hardly been formed. The well of W. G. Davis presented some peculiarities. At 96 feet a granite-like rock was encountered, and the drill cut through a 4-foot layer of this, making the well 100 feet deep in all. The suction pipe was set directly on top of this rock, and no screen was used. The well furnished more than an ample supply of clear, fresh water. The machinery consists of a 22-horsepower Foos gasoline engine and a 6-inch Morris pump. Sixty acres of Japan rice

were irrigated during the season of 1902, but the well had water for double this acreage. The following is a list of the plants near Louise, with the amount of rice sowed: W. G. Davis, 60 acres; G. W. Barnett, 50; Otto Peterson, 40; E. M. Clark, 400; Saddler & Rome, 250; Saddler & Thomason, 200; Saddler & Thomas, 240; total, 1,240 acres. When visited in July the only plants that had water on them were the Davis and the Peterson, and it is very probable that the Louise plants will not average over half a crop this year.

JACKSON COUNTY.

Moritz and Mayfield systems.—Near Ganado, just over the line in Jackson County, M. P. Moritz and D. B. Mayfield have opened up rice farms of about 100 acres each. The former uses a 5-horsepower gasoline engine to pump from a well 56 feet deep with 20 feet of water-bearing sand. It is estimated that in a dry year one good well will irrigate 80 acres of rice. The Mayfield plant adjoins that of Moritz, and derives its water from a well 67 feet deep with 30 feet of water-bearing sand.

The acreage around Ganado in 1902 was as follows: D. B. Mayfield, 50; N. P. Mauritz, 200; A. W. Everitt, 50; L. Ward, 75; Boquette, 60; total, 430 acres.

COLORADO RIVER BELOW WHARTON.

Bay Prairie Irrigation Company system.—Eight miles below Wharton and surrounding Lane City is the rice farm of the Bay Prairie Irrigation Company (often called the Lane Company). The pumping plant is on the banks of Colorado River, from which it takes its water, at a distance of 16,700 feet from the depot at Lane City. There were two pumping plants in 1901, but it is intended to add a third in order to bring more land under ditch. When completed the system will command 15,000 acres. The plant at the river consists of two Van Wie pumps having 54-inch discharge, operated by a Bates-Corliss engine of 1,250 horsepower. The lift is 33 feet, and the capacity is estimated at 70,000 gallons a minute. The engineer, L. E. Beadle, estimates that it will require 8 gallons a minute for each acre, but he has provided for emergencies by installing pumps having a capacity of 10 gallons a minute for each acre. There are two flumes, one at the river and the other across Jarvis Creek. The former is 5 feet by 12 feet by 182 feet long, while the latter, which is 1¼ miles from the river, is 4 feet by 20 feet by 350 feet long. There are 11 miles of main canals 120, 100, and 80 feet wide. At the second lift an Atlas-Corliss engine of 200 horsepower operates a 24-inch Van Wie pump estimated to have a capacity of 30,000 gallons a minute under the lift of 5 feet. The soil is black. The farm lies on each side of the Cane Belt Railroad. The water is carried under the tract by a terra cotta and timber invert. The plant, exclusive of land, cost $125,000. Six thousand five hundred acres were irrigated in 1901. It is intended to increase this in 1902 to 15,000 acres. This company

offers the most liberal terms to renters of any irrigation systems examined. It furnishes land, water, and seed for three-sevenths instead of one-half of the crop, thus giving the renter an advantage of 6 per cent.

Since writing the above the third lift has been added and the plant at the second lift has been transferred to the third lift. The capacity of the river plant is now 120,000 minute-gallons, and the plant at the second lift consists of one 250-horsepower engine, operating a 45-inch

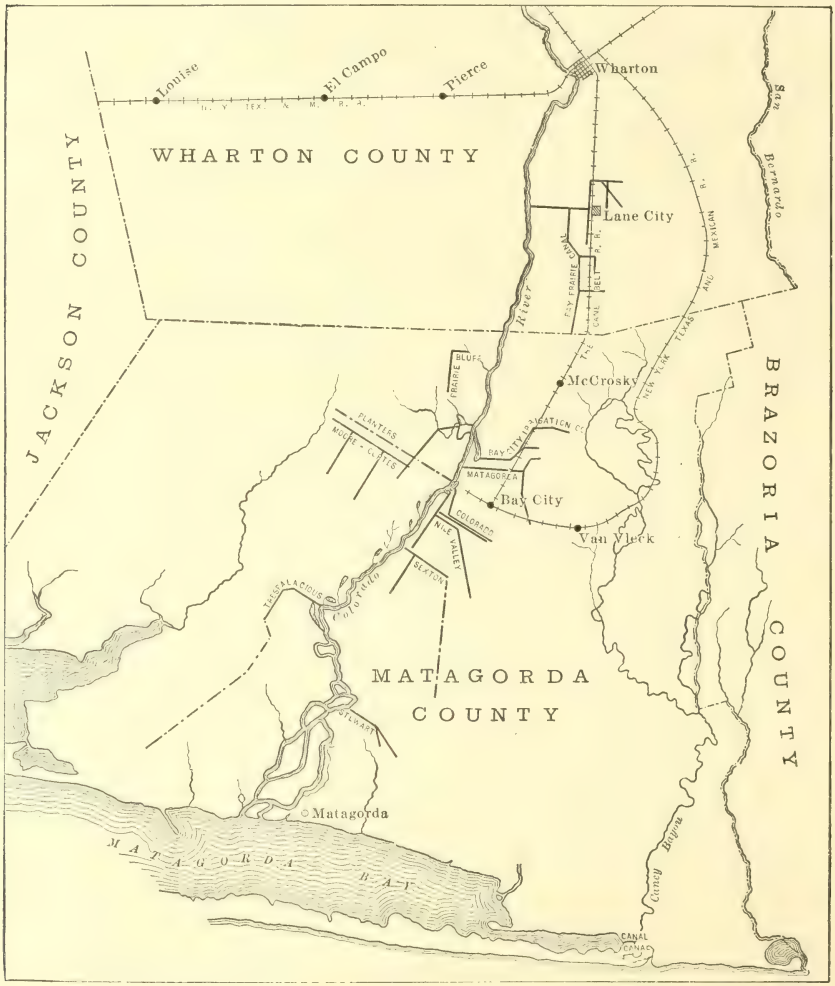


FIG. 27.—Map showing irrigation systems in Colorado Valley below Wharton.

centrifugal pump which has a capacity of 50,000 minute-gallons; at the third lift, a 200-horsepower Atlas-Corliss engine, operating a 24-inch Van Wie pump, which, with the lift of 3½ feet, has a capacity of 20,000 minute-gallons. In 1902 there were under the first lift 9,500 acres, under the second 5,000, and under the third 1,500, making a total of 16,000 acres under canal, and 15,000 acres of these were irrigated during the current season.

A. BUILDING LEVEES FOR RICE-FARM CANALS, WITH ENGINE AND GRADING MACHINE, IN MATAGORDA COUNTY.

B. BREAKING SOD WITH ENGINES, FOR RICE PLANTING, NEAR BAY CITY, MATAGORDA COUNTY, MARCH, 1902.

Capacity of engine, about 50 acres per day and night.

MATAGORDA COUNTY.

Near Bay City, in Matagorda County, eight large companies have opened up extensive rice farms. The Bay City Irrigation Company, the Nile Valley Company, the Colorado Company, the Stewart, the Sexton, and the Matagorda Rice and Irrigation Company have plants on the east side of the river, while the Moore-Cortez, the Planters, the Prairie Bluff, and the Trespalacious are on the west side, as shown by fig. 27. Not only is heavy machinery used in pumping the water, but the heaviest traction engines are used both in making the levees and in plowing the land. One traction engine of 30 horsepower, with its plows, can break up 2 acres per hour. Pl. VIII, *A* and *B*, shows the methods of levee making and steam plowing.

Moore-Cortez Canal Company system.—The Moore-Cortez Canal Company installed for the season of 1901 a large plant about 6 miles from Bay City. They own and control 20,000 acres of land, and have located their pumps on a small lake. The plant consists of one 300-horsepower Vilter-Corliss engine, operating an Ivens centrifugal pump having two 30-inch suction pipes, and an estimated capacity of 56,000 gallons a minute (124 second-feet) under a lift of 12 feet. The main canal is 7 miles long and 100 feet wide. The length of the main laterals is 10 miles and the width 40 feet. The whole plant, exclusive of land, cost $50,000. Five thousand five hundred acres were irrigated in 1901, yielding 10 sacks to the acre, selling for from $2.50 to $4.50 a sack. For the part of the land that is rented the company charges one-fifth of the crop for land rent and one-fifth for water. In 1902 10,000 acres were irrigated.

Bay City Irrigation Company system.—The pumping station of the Bay City Irrigation Company (Victor La Tulle, manager) is 3 miles north of Bay City and takes water from a lake connected with Colorado River. The plant consists of two 24-inch Morris pumps and two 140-horsepower Erie City engines. The capacity is 50,000 gallons a minute (111 second-feet) under a head of 12 feet. The water is delivered into a flume 3 feet by 12 feet 100 feet long. There are 7 miles of main canals, 125 feet from center to center of embankments. The cost of the plant, exclusive of land, was $30,000. The soil is a black hog-wallow with a slight admixture of sand. The plant was operated for the first time in 1901, when 4,000 acres of rice were irrigated, producing 10 sacks to the acre. This plant watered 5,000 acres in 1902.

Matagorda Company system.—Adjoining the lands of the Bay City Company are those of the Matagorda Company. The pumping plant is 2 miles northwest of Bay City, and consists of one 360-horsepower Greenwold engine and one 100-horsepower Nagle engine. There are two Worthington pumps and one Menge pump. The discharge pipes of the Worthington pumps are 20 inches by 40 inches, while the Menge pump discharges through a penstock 6 by 6 feet. The joint capacity of the former is 64,000 gallons a minute and of the latter

22,000 gallons a minute, or a total of 86,000 gallons (191 second-feet), under a lift of 98 feet. It is to be remarked that this is about equal to the lowest flow of Colorado River at Austin. The total cost of the plant, exclusive of land, was about $55,000. The plant was used to irrigate 540 acres of land in 1900, the yield being 12 sacks to the acre, which commanded $3.60 a sack, net. In 1902 the acreage was increased to 9,000 acres.

Colorado Company system.—Near the Matagorda plant is that of the Colorado Canal Company. This plant is located on an intake connecting with a lake, which in turn at certain stages of the river connects with it. The machinery consists of a Murray Brothers 200-horsepower compound condensing engine and a Connersville blower pump, with discharge pipe 32 by 96 inches. The lift varies from 8 to 12 feet, depending upon the stages of the river and lake. It requires 20 barrels of Beaumont oil per day, which costs at Bay City 43 cents per barrel, making a total cost of $8.60 per day for fuel. The capacity of the plant is 50,000 minute-gallons. During the present season 5,300 acres were irrigated.

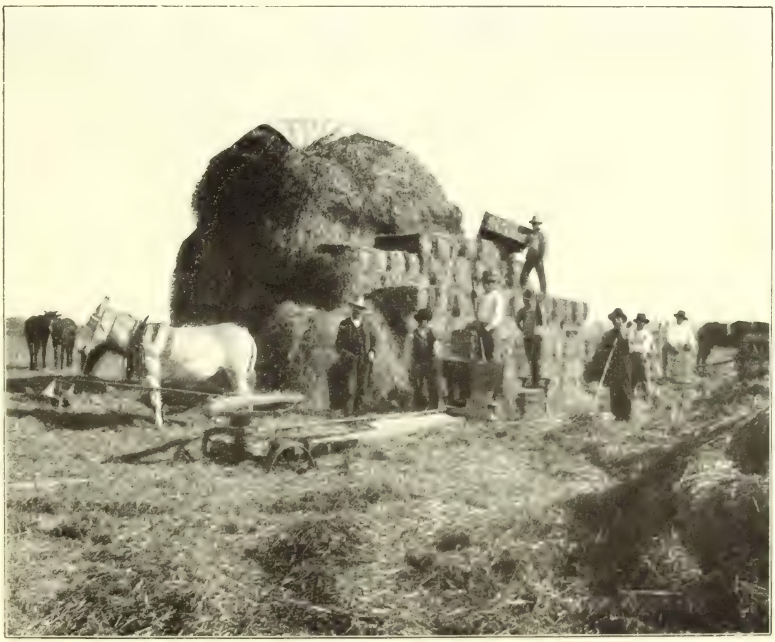
Nile Valley system.—The Nile Valley plant is on the banks of the Colorado River, less than one-fourth mile from that of the Colorado Company. This plant takes its water directly from the Colorado River one-half mile above the head of the famous raft. Two 80-horsepower duplex engines operate the two 30-inch Morris pumps against the maximum lift of 8 feet. The canal of this company forms a levee and serves to protect Bay City and the lands below. Twenty-two barrels of Beaumont oil are used per day. In 1900 2,500 acres were irrigated from this canal. Pl. IX, A, is a view of the pumping plant at the Nile Valley plant.

Stewart system.—At the Stewart canal an 80-horsepower engine operates a 24-inch Morris pump against a maximum lift of 21 feet. In 1902 1,700 acres were irrigated by this canal.

Sexton system.—The Sexton plant uses a simple 80-horsepower Greenwald engine and a Menge pump under a lift varying from 18 to 20 feet. This plant irrigated only 500 acres this season. On the west bank of the Colorado River two new plants have been projected, the Trespalacious and the Planters. The former is below Bay City, while the latter takes its water from below the Moore-Cortes pumping plant, but its canal crosses that of the Moore-Cortes Company and irrigates land above. The Planters Canal Company was late in starting, and only 950 acres were irrigated in 1902. The Prairie Bluff Rice Company has located its canal on Blue Creek above the Moore-Cortes and the Planters canals. It also was late in starting, and during the current season irrigated 350 acres of rice.

Summary of Matagorda plants.—Following is a summary of the Matagorda County plants: Bay City Irrigation Company, 5,000 acres; Matagorda County Rice Company, 9,000; Colorado Company, 5,300;

A. NILE VALLEY PUMPING PLANT.



B. BALING RICE STRAW FOR HAY, NEAR BAY CITY.

Nile Valley Company, 2,500; Stewart Canal Company, 1,700; Sexton Canal Company, 500; Prairie Bluff, 350; Moore-Cortes, 10,000; Planters Canal Company, 950; S. J. Cleveland, 160 acres; total, 35,460 acres.

GUADALUPE RIVER.

DEWITT COUNTY.

The only water-power plant in Texas that irrigates rice is that of Otto Buchel, 3 miles north of Cuero. A masonry dam across the Guadalupe River produces an effective head of 10 feet. This is one of the most substantial dams in Texas, and it cost, with its equipment, $100,000. The power is generated by 54-inch turbines, which operate the pumps to raise water into an adjacent reservoir. An auxiliary steam plant of 400 horsepower is used for supplementing the energy generated by the water plant. This plant furnishes power for three rice farms—Mr. Buchel's, Schleicher & Crouch's, and Rathbone and Wofford's. The farm of Schleicher & Crouch is above that of Buchel and on the east side of the river. The power for operating the pumps is transmitted electrically from the Buchel power plant. The farm of Rathbone & Wofford is on the west side of the river, and also receives its power by electric transmission from the Buchel plant. In all, 750 acres of rice were irrigated at these farms in 1902.

VICTORIA COUNTY.

The plant of the Victoria Rice and Irrigation Company is located 10 miles south of Victoria, and takes its water from the Guadalupe. On the east side, at the first lift on the river, there are two 235-horsepower Brownell engines operating the pumps against a lift of 22 feet. The river plant delivers the water into a flume 1,400 feet long, and this empties into a reservoir 24 by 125 feet by 9 feet deep. The second lift is 41½ feet, and two 525-horsepower Corliss engines operate the pumps. The second flume is 400 feet long and delivers the water into the main canal. There are 5 miles of 100-foot canals, 2 miles of 75-foot laterals, and 2 miles of 60-foot laterals. The highest point of land to be irrigated is 62 feet above the ordinary water level of the river, and there is a fall of 18 inches from the second lift to this highest land. In 1902 2,700 acres were irrigated. Wood is used as fuel at present, but it is the intention to substitute Beaumont oil soon, transporting it down the canal by boat to the plants.

Four miles west of Victoria Harry Rathbone has 60 acres in Japan rice this season. He derives the water from Pridhams Lake, and a 6-horsepower engine operates the 5-inch centrifugal pump under a lift of 8 feet. The soil is sandy river bottom. Twelve miles above Victoria John T. Rusk has a well-plant rice farm, but lateness in obtaining water renders its acreage doubtful for this season.

BROWNSVILLE IRRIGATION SYSTEM.

The center of rice culture in Texas takes its way considerably westward for 1902, on account of the big irrigation system near Brownsville, on the Lower Rio Grande. During 1901 this system was experimental, consisting of the machinery of an unused irrigation plant. The experiment was so successful, however, that the company, the Brownsville Land and Irrigation Company (W. M. Ratcliff, manager), has made plans to extend the system on a large scale, at a cost of $250,000. The plant is 5½ miles below Brownsville. Rice, sugar, and cotton will be raised by irrigation. The plant now consists of one 300-horsepower Chandler & Taylor engine and an Ivens centrifugal pump, having 28-inch suction and 24-inch discharge pipes, and an estimated capacity of 80 second-feet under the lift of 11½ feet. The horsepower of the engine, if actual, ought to treble this discharge. The water is first pumped into a flume 3 feet by 18 feet by 40 feet long, and then is delivered into the canals. The main canal is 12 miles long and 120 feet wide, and there are 16 miles of laterals 100 feet wide. The fuel used is mesquite wood.

AREA DEVOTED TO RICE CULTURE, BY COUNTIES.

	Acres.		Acres.
Jefferson	44,380	Cameron	3,000
Matagorda	35,460	Victoria	2,770
Wharton	23,600	Austin	1,220
Liberty	16,200	Galveston	800
Colorado	11,450	Washington	780
Orange	10,850	Dewitt	750
Harris	9,100	Jackson	430
Chambers	9,000	Waller	400
Fort Bend	8,830		
Brazoria	3,150	Total	182,170

PROPOSED PLANTS.

In addition to the systems described above there will be several big plants operating in 1903. The Treadway Canal Company will take its water from the Neches River 8 miles northwest of Beaumont and irrigate land on each side of the Southern Pacific Railroad. It is contemplated to bring 25,000 acres in cultivation by this canal. The canals are already under construction.

The Texas Land and Irrigation Company is installing a plant to take its water from the Brazos River northeast of Wallis. Its canal, already under construction, will extend in a southerly direction, and it is intended to bring the land between Wallis, Rosenberg, and East Bernard under canal.

The Illinois Irrigation Company proposes to take out a canal from the Brazos River north of Sealy, near San Felipe, and irrigate lands north and south of Sealy.

The San Jacinto Rice and Irrigation Company expects to put in a plant on the San Jacinto River east of Houston in 1903.

The Wallace-Radford Company intends to irrigate lands east of Eagle Lake by a canal system to take water from Colorado River.

APPENDIX.

The following statement of the Texas laws pertaining to irrigation was prepared by Judge John C. Townes, professor of law in the University of Texas:

A water course, as the words are used in this connection, has been defined as "a stream usually flowing in a particular direction, though it need not flow continually. It may sometimes be dry. It must flow in a definite channel having a a bed, sides, or banks, and usually discharges itself into some other stream or body of water." 27 Wis., 661. Cooley Torts, 238.

It will be observed that the water supply need not be sufficient to cause the stream to flow all the time. It must flow habitually, though not necessarily uninterruptedly. There must be a definite channel; that is, a bed or place where the water passes along over the same depression or lower surface, which is bounded or limited by ascertained and definite sides or banks. When these things occur, the water thus confined and seeking a regular outlet is a water course or stream. Water standing in a depression and not flowing is not a stream. Water flowing not in a defined channel, as surface water after a rain, is not a stream. In our changeable climate it is sometimes difficult to determine the question as a fact regarding any particular body of water. Sometimes there is a well-defined channel, but no water except immediately after rains; again there are channels down which water flows frequently, but not continuously. How often it is to run and how long during the year must be answered from the facts in each case. If there is a well-defined channel down which water passes usually—habitually—it is enough, though it may sometimes be dry. If, however, it is usually dry, with water flowing in it only occasionally, it is not a stream.

The water passing in these streams is not owned by anyone. The proprietors of the land crossed by or bordering on the stream have legal rights in its use, but have no property in the water itself. These rights, like all others, have their correlative duties, and the proprietors of the several estates must have regard at all times to the obligations under which each rests toward the other. All persons who own land along a stream are coproprietors in its use. These uses are of two kinds—domestic or natural on the one hand, and artificial or commercial on the other hand. As to the first, the right of use is very extensive, and the proprietor who first gets access to the water lawfully may completely exhaust it in these natural or domestic uses without incurring liability in so doing. It is not so with the second—the artificial or commercial use. Here no one has an exclusive privilege. The upper proprietor can use it for these purposes provided that after this use he permits it to leave his land at the same place, in the same quantity, and of the same quality that it would have but for such use.

It is apparent that the rights and liabilities of the parties vary greatly as the use made of the water is of the one or the other class. It therefore becomes important to understand what uses fall in each class. Domestic or natural purposes embrace drinking purposes for one's family and his own domestic animals culinary purposes, and washing, and all the uses about one's premises necessary

to sustain life. Artificial or commercial uses are all those in which water is not used directly to sustain life or to give comfort, but is a means of pecuniary profit or indirect means of comfort. This seems to be the line of separation. It works out different results in different localities. It seems to be considered everywhere that the uses mentioned under the head of domestic purposes are such, and that for any of these purposes the upper proprietor or the one first getting lawful access to the water may use it to the entire exhaustion of the supply.

The following are the decisions of the supreme court of Texas:

FLEMING *v.* DAVIS, 37 TEX., 173; APPEAL FROM SAN SABA COUNTY, 1872.

Syllabus 2.—Irrigation of land, however beneficial in some portions of this State, is not one of the natural wants which will justify the owner of a head spring in exhausting the water which flows from it, to the injury of proprietors lower down on the natural channel of the stream. The maxim *sic utere tuo ut alienum non laedas* applies. The case of Tolle *v.* Correth, 31 Tex., 362, is not understood to have decided a contrary doctrine.

Syllabus 3.—In the distribution of the water of a natural stream among the riparian proprietors the principles of the common law furnish the only rules judicially known in this State; and a suit, it seems, can not be sustained to partition a natural stream among riparian proprietors by allotting to each a specified time to appropriate its waters.

BAKER *v.* BROWN, 55 TEX., 377; APPEAL FROM SAN SABA COUNTY, 1881.

Syllabus 1.—The right to use water for purposes of irrigation, when its use is not indispensable, but is resorted to for the purpose of increasing the products of the soil, must be subordinate to the right of a coproprietor to supply his natural wants and those of his family, tenants, and stock, by using the water for necessary and domestic purposes.

Syllabus 2: Limitations; riparian rights.—The rights of a riparian proprietor to the use of the water may be restricted or lost by grant or by prescription, under such adverse, continuous, uninterrupted user and occupation by another as would, by analogy to the statute of limitations, bar the right of entry upon lands. Ten years' use and occupation would in Texas be the period of prescription.

MUD CREEK IRRIGATION CO. *v.* VIVIAN, 74 TEX., 171; APPEAL FROM KINNEY COUNTY, 1889.

Syllabus 1: Irrigation corporations.—An irrigation company chartered under general law and whose charter designates the locality of its canals acquires thereby no exclusive right to the use of the waters of a flowing stream on which it depends for its supply. By virtue of the charter of its incorporation, which authorized the acquisition by gift, purchase, or condemnation of all property necessary to the irrigation enterprise, it secured the right to obtain in the manner designated the privilege of using the water of a stream, but the charter did not *proprio vigore* confer that right in the absence of a purchase, gift, or condemnation.

Syllabus 2: Constitutional law.—The legislature can not destroy or impair the vested rights of a riparian proprietor by conferring a special privilege on an irrigation company without providing for the payment of a just compensation.

Syllabus 3: Riparian proprietors; irrigation cases reviewed.—Tolle *v.* Correth, 31 Tex., 365, and Fleming *v.* Davis, 37 Tex., 173, reviewed, and the doctrine announced that a riparian proprietor has the right to divert water flowing along or through his land to purposes of irrigation, although the effect of such use is to leave to a riparian proprietor on the stream below him a supply of water insufficient for irrigation. No opinion is expressed as to whether water can be used by a riparian proprietor for irrigation so as to render insufficient the supply for ordinary use to those owning land lower down the stream.

Syllabus 4: Prescription.—A prescriptive right to use water for irrigation will be acquired by the uninterrupted use of the water for such purpose under a claim of right. But this right can only be enforced against riparian proprietors on the stream below when the water has been continuously used for ten years under a claim of right. It can not be asserted against a riparian proprietor by or through whose land the water flowed before it reached the point below where it is appropriated by the one claiming the prescriptive right.

Syllabus 5: Presumption of grant.—The presumption of a grant from long continued enjoyment can exist only as against those who might have prevented or interrupted the use of the subject of the supposed grant.

In rendering the opinion in this case, Judge Gaines said:

"It is true that the act of March 10, 1875, provides that 'any * * * canal company shall have the free use of the waters and streams of the State,' but the provisions of that act applied as well to ordinary companies as to corporations. Laws, 2d sess., 14th Leg., 77. Besides, we are of the opinion that the provision could be held only to apply to streams upon the public lands of the State, since the legislature had no power to take away or impair the vested rights of riparian owners without providing for the payment of a just compensation. If the defendants or the owners of the land along the stream in controversy had the right to use the water for the purpose of irrigating their lands, that right remained unaffected by the plaintiff's incorporation or by the legislation of the State passed for the encouragement of irrigation. It seems to be the rule of the common law that a riparian owner has no right to use the water of the stream for irrigating his lands, provided it interferes with the uses of the water by those who own the lands upon the stream below. That this is a proper rule in England and in those States where the rainfall is sufficient for the purposes of agriculture we freely concede, but we are of opinion that in those sections where irrigation is necessary to the successful pursuit of farming it should not apply. What is not a necessary use in the one case becomes necessary in the other. Evans *v.* Merriweather, 3 Scam. (Ill.), 496. It was so held in Tolle *v.* Correth, 31 Texas, 265, and though this decision was criticised in the subsequent case, Fleming *v.* Davis, 37 Texas, 173, we are of the opinion that it recognizes a correct rule of law as applied to the present case.

"We think it a matter of common knowledge that there are portions of our State where the business of agriculture can not be successfully prosecuted through successive years except by irrigation, and it is to be inferred from the allegations of the petition that the section where the stream in controversy is situated is of that character. We think, therefore, that the defendants had the right to divert the water which flowed in the stream along or through their lands for the purpose of irrigating them, although the effect of such use was to leave the plaintiff corporation an insufficient supply for the same purpose. Whether they had the right to divert the whole of it and leave an insufficient supply for the ordinary use of the lower riparian owners we need not in this case determine."

From these cases it is clear that the purposes named above as domestic are regarded as such in this State, and that irrigation ordinarily is not such a use, but that if in any particular locality the business of agriculture can not be successfully prosecuted through successive years except by irrigation, such use in such locality may be regarded as domestic, in a qualified sense: that is, so far as to give the right to so use the water, even though it may deprive lower proprietors of the opportunity of similar use, though this can not be done to the extent of cutting off the supply for drinking water, household purposes, or for stock.

INDEX.

A. Page.

Adams, Adam, area irrigated by 116
irrigation plant of 112-113
Adams Bayou, rice cultivation on 98
Alamo Creek, ditches along 20
Alamo Madre ditch, history of 52
Aldridge, Hal, area irrigated by 97
Alfalfa, prices obtained for 23
Algoa, rice cultivation near 102
Alice, irrigation on King ranch near 60
Alkali, impregnation of soil with 23
Allen, J. A., irrigation plant of 45
Altair, rice irrigation near 110
Alvin, rice cultivation near 102
Angleton, rice cultivation near 106
Arcola Junction, rice cultivation near 105
Armstrong, G. R., irrigation plant of 44
Arocha Spring Creek, irrigation from 21
Artesian wells, irrigation from, in and near San Antonio 54-56
Austin County, rice cultivation in 103-104
rice culture in, area devoted to 124

B.

Bacek, John, area irrigated by 118
Baker, George, irrigation plant of 38
Baker Brothers, well plant of 111
Bailey Creek, irrigation from 46
Baldwin, Henry, irrigation plant constructed by 49
Baldwin, J. A., irrigation plant of 48
Ball, Antonio, springs in section owned by 15
Ball, Tom, irrigation plant of 30
Bandera County, irrigation in 41-42
Bard, Axel, area irrigated by 118
Bardhardt, M., area irrigated by 118
Barksdale, irrigation near 39, 40, 41
Barnet Spring, irrigation from 38
Barnett, G. W., rice cultivation by 119
Barrett, C. C., irrigation plant of 48-49
Barstow, irrigation near 23
Bartel, A. H., irrigation plant of 106-107
Bastrop Bayou, irrigation from 106
Batesville, irrigation near 67
Bay City, rice cultivation near 121
rice planting near, plate showing engines breaking sod for 120
Bay City Irrigation Company, area irrigated by 122
plant of 121
Bay Prairie Irrigation Company, plant of 119-120

Page.

Baze irrigating ditch, features of 74
Bear Bayou, rice cultivation on 101
Bear Creek, irrigation from 49-51
Beard, rice cultivation near 114
Beaumont Irrigation Company, farm of, map showing location of 86
flume of, elevation and section of 94
rice cultivation by 94-95
Beaumont section, land in, character and extent of 82
rice irrigation systems in 86-102
map showing 86, 87
Bee County, irrigation in 59-60
Bee Star gardens, irrigation plant of 59
Beeville, irrigation plants in and near 59-60
Beeville irrigated gardens, irrigation plant of 59
Begg, George, irrigation plant of 75-76
Bell County, irrigation in 76
Bender, Fritz, area irrigated by 118
Bent, J. A., well plant of 115
Berglund, P. E., rice cultivation by 117
Bering, C. L. and C. H., rice cultivation 101
Bering, Conrad, rice cultivation by 101
Bernard Rice Company, area irrigated by 116
plant of 115
Berry Brothers, area irrigated by 111
Bexar County, irrigation in 51-58, 64
Big Bend, irrigation systems in 19-21
land along Rio Grande in, character of 19
Bigham Brothers, rice cultivation by 91-92
Bismarck ditch, irrigation by 72
Black Place, irrigation of 48-49
Blanchard, L. F., irrigation plant of 77
Bluffton, irrigation at 76
Blumquist, Fred, rice irrigation by 117-118
Boehm Brothers, area irrigated by 118
Bone, E. D., area irrigated by 111
Boquette, ——, rice cultivation by 119
Boquillas, irrigation systems near 20
Borden, A. P., area irrigated by 118
Brackett, irrigation systems near 28-30
Brady, T. F., irrigation plant of 55
Brandon Brothers, rice irrigation by 110
Brazoria County, rice cultivation in 105-107
rice culture in, area devoted to 124
Brazoria Rice and Irrigation Company, plant of 105
Brazos Canal Company, pumping plant of 105
Brazos River, irrigation near 80-82
rice cultivation along 82
rice irrigation from 105

Page.
Brazos Valley section, rice cultivation in ... 103-107
Brenham, rice cultivation near ... 103
Brewster County, irrigation systems in ... 20
Brogado, irrigation near ... 17
Brooks, S. J., irrigation plant of ... 77
Brown, B. H., irrigation plant of ... 57-58
Brown & Son, rice cultivation by ... 99
Brown County, irrigation plants in ... 74-75
Brownsville, irrigation systems at and near ... 69-70
rice cultivation near ... 124
Brownsville Land and Irrigation Company, plant of ... 124
Brownwood, irrigation plants near ... 74-75
Bruemmen, W., irrigation plant of ... 61
Brulay, George, irrigation plant of ... 69
Brunes, Chris., area irrigated by ... 118
well plant of ... 116-117
Buchanan, J. P., rice cultivation by ... 103
Buchanan, W. E., rice cultivation by ... 103
Buchel, Otto, irrigation plant of ... 123
Buffalo Bayou, rice irrigation from ... 101
Bugbee, L. G., acknowledgments to ... 13
Bullard, J. B., irrigation plant of ... 44
Burglund, A., area irrigated by ... 118
Burnet County, irrigation in ... 76
Burr, O. A. V., irrigation plant of ... 41
Burrows, ——, area irrigated by ... 97
Butler, W. P., irrigation plant of ... 63
Byers's vineyard, dam at, features of ... 30

C.

Cabaniss, J. E., well plant of ... 101
Cahn, L., area irrigated by ... 118
Cajac Creek, irrigation from ... 46-47
Cameron, irrigation near ... 77
Cameron & McClure, farm of, map showing location of ... 86
rice cultivation by ... 93
Cameron County, irrigation in ... 68, 69-70
rice culture in, area devoted to ... 124
Camille irrigation plant, features of ... 58
Camp, B. W., rice cultivation by ... 102
Campbell artesian well, depth and flow of ... 65
Campswood Creek, irrigation from ... 39, 40-41
Canals, levees for, plate showing building of ... 120
Candelaria ditch, features of ... 19
Carlsbad, N. Mex., storage reservoirs near ... 21
Carlson, A. E., area irrigated by ... 118
Carlson, J. B., rice irrigation by ... 117, 118
Carr, Will, area irrigated by ... 111
Carrizo Springs, artesian water near ... 65
irrigation at and near ... 64
Carrizo Springs, use of, for irrigation ... 65
Casey, B. F., irrigation plant of ... 41
Catron, F. H., rice-irrigation plant installed by ... 97
Cedar Creek, irrigation from ... 45-46
Chambers County, rice cultivation in ... 98-99
rice culture in, area devoted to ... 124
rice irrigation in, map showing ... 87
Channing, irrigation near ... 79

Page.
Chase, John, irrigation plant of ... 106
Chesterville, rice cultivation near ... 104
well plants near, features of ... 113-114, 115
China, wells near, rice irrigation from ... 96-97
Chittim, J. M., area irrigated by ... 60
Christmas Spring, irrigation from ... 48
Cienagas Creek, irrigation from ... 27
Clark, E. M., rice cultivation by ... 119
Clark Canal Company, plant of ... 98
Clear Creek, source and character of ... 30-31
Clements, E., irrigation ditches controlled by ... 17
Clements, J. H., irrigation plant constructed by ... 45
Clements ditch, map showing ... 16
Clementson, John, irrigation plant of ... 60
Cleveland, S. J., area irrigated by ... 123
Clodine, rice cultivation near ... 100-101
Closner, irrigation plant of ... 69
Clymer, M., irrigation plant of ... 39
Coghlan ranch, irrigation at ... 30
Collins, F. F., irrigation plant of ... 54-55
Colorado Canal Company, plant of ... 122
Colorado County, rice cultivation in ... 107-115
rice culture in, area devoted to ... 124
Colorado River, irrigation from ... 76
irrigation systems north of ... 76-82
rice cultivation along ... 82
rice irrigation from ... 107, 108, 109, 110-111, 119-120
Colorado Valley, irrigation systems in ... 70-76
irrigation systems in, below Wharton, map showing ... 120
Colorado Valley section, rice cultivation in ... 107-123
well plants in ... 111-115
Columbia, rice cultivation near ... 106
Comal County, irrigation in ... 60-61
Comal River, irrigation plants on ... 60-61
Comanche, irrigation near ... 80
Comanche Creek, character and flow of ... 17
irrigation from ... 17-19
Comanche Creek Irrigation Company ditch, features of ... 18
Comanche Irrigation Company, ditch of, map showing ... 67
plant of ... 67
Conception ditch, history of ... 52
Concho River, irrigation from ... 70-74
Connell, W. A., irrigation plant of ... 40
Cook, M. E., pumping plant on farm of ... 37
Copp, George, irrigation plant of ... 63
Cordz, H., area irrigated by ... 116
Cornick, Boyd, irrigation plant of ... 74
Cotulla, irrigation plants at and near ... 63-64
Cow Bayou Canal and Irrigation Company, farm of, map showing location of ... 86
rice cultivation by ... 97
Coyote Creek, irrigation from ... 19
Crain, J. M., irrigation plant of ... 77
Crawford, J. H., irrigation ditch owned by ... 19
Cuero, rice cultivation near ... 82, 123
Cunningham farm, irrigation plant on ... 71-72

D.

Page.

Daisy, rice cultivation near 101
Danielsen, A., rice irrigation by 118
Davis, J. H., irrigation plant of 64
Davis, W. G., irrigation plant of 118, 119
Dawson, G. S., irrigation plant of 19
Del Rio, dams at, plate showing 26
ditches at, area irrigated from 26
irrigation system at, features of 25–26
map showing 26
Del Rosa ditch, features of 19–20
Del Valle, irrigation plants near 75–76
Denis, W. H., ackowledgments to 13
Des Moines Rice Company, farm of, map showing location of 86
irrigation plant of 97, 98
Dewitt County, rice cultivation in 123
rice culture in, area devoted to 124
Dickey, S. P., rice cultivation by 101
Dignowitty, A. F., irrigation plant of 55–56
Dimmit County, irrigation in 64–65
Dismukes, E., irrigation plant of 81
Dittmar, Adolph, irrigation plant of 61
Dobbins, R. B., area irrigated by 116
Dobbins, S. C., acknowledgments to 13
Dolan, Pat, irrigation plant of 63
Dolch, L. F., irrigation plant of 68
Donathan, W. H., irrigation plant of 77
Doran, W. R., irrigation plant of 36–37
Dougherty, A. H. D., irrigation plant of 47–48
Dove Creek, irrigation plant on 74
Drainage, importance of 23
Driscoll, irrigation near 60
Dryden, irrigation near 20
Duncan, John, area irrigated by 111
Dunovant, William, rice cultivation by 107–108
Dupuy, R. T., irrigation plant of 46

E.

Eagle Lake, irrigation canals at, map showing 108
rice cultivation near 82, 107–110, 112, 114
Eagle Lake, rice irrigation from 107–110
Eagle Lake Rice Company, pumping plants of 108–110
siphon of, cross section of 109
Eagle Pass, irrigation near 68
East Bear Creek, irrigation from 49
Edwards County, irrigation in 39–42, 48–49
soil in, character of 39
Edwards Plateau, boundaries of 25
irrigation systems in 25–51
Eidson, R. I., area irrigated by 60
El Campo, well plants near 116, 117, 118
Elliott, J. H., area irrigated by 60
Ellis, Robert, irrigation plant of 37
Elms, H., irrigation plant of 41
El Paso Irrigation Company, dam of, plate showing 14
El Paso Valley, climate of 15
irrigation systems in 13–15
map showing 14
Embry, J. R., rice irrigation by 118
Epp, John, irrigation plant of 55
Erin, rice cultivation near 100
Ernst, A., irrigation plant of 20
Espada ditch, aqueduct carrying, plate showing 52
history and features of 53–54
Espada Ditch Company, organization of 53
Etheridge, J. H., irrigation plant of 42
Etheson, A., irrigation plant of 81
Etheson, Robert, irrigation plant of 81
Eule, William, well plant of 101
Evarts, B. A., well plant of 101
Everett, J. M., area irrigated by 116
Everitt, A. W., rice cultivation by 116

F.

Fairland farm, irrigation of 75
Farrar, Mrs., lands of, irrigation of 38
Faulkner, C., irrigation plant of 81–82
Fayetteville, rice section extended to 82
Finlan, Owen, irrigation plant of 75
Fischer, C. F. H., irrigation plant of 61
Fleming Springs, irrigation from 37
Flemming, O. B., irrigation plant of 47
Flood, damage caused by, in 1897 15
Floresville, irrigation near 58
Ford Hollow Spring, irrigation from 48
Fort Bend County, rice cultivation in 101, 104, 105
rice culture in, area devoted to 124
Fort Bend Irrigation Canal Company, pumping plants of 104, 105
Fort Clark Reservation, ditch used by Indians living on 28
Fort Inge, irrigation near 66
Fort McKavett, irrigation near 30
Fort Stockton, irrigation systems near 17–19
irrigation systems near, map showing 18
Foster, H. L., well plant of 114
Franklin Irrigation Company, canal owned by, features of 13, 14
map showing 14
Freeman, I., irrigation plant of 62
Freeman, J. R., irrigation plant of 62

G.

Galveston County, rice cultivation in 102
rice culture in, area devoted to 124
Ganado, rice cultivation near 119
Gardner, A. F., irrigation plant of 33
Garetzky, Frank, area irrigated by 118
Garland, J. G., farm of, map showing location of 86
rice cultivation by 89
Garret, D. C., irrigation plant of 62
Garwood, rice irrigation near 111
Garza ditch, features of 18
Genoa, rice cultivation near 102
Georgetown, irrigation near 77
Giles Brothers, irrigation plant of 98
Gill, George, farm of, map showing location of 86
rice cultivation by 88, 89
Glenmore farm ditch, irrigation by 71, 72
Glover, Frank, irrigation plant of 62
Goodrich, E. H., irrigation plants of 69–70
Gordon, C. K., irrigation plant of 43, 50–51
Gordon, S. M., well plant of 101

Page.
Government ditch, features of 28
Graham, Oscar, irrigation plant of 41
Grand Falls, irrigation near, map showing 24
Grand Falls Irrigation and Improvement Company, canal of, features of 24
Grapes, cultivation of, at Del Rio 26
Gray, George, rice irrigation by 114-115, 116
Griffith, S. A., irrigation plant of 46-47
Groos, F., irrigation plant of 57
Guadalupe County, irrigation in 58, 62
Guadalupe River, irrigation plants on 42, 61
rice cultivation along 82, 123
Gulf Rice Growing Company, farm of, map showing location of 86
irrigation plant of 92

H.

Hackberry Creek, irrigation from 39
Hackborth & Koy, well plant of 103
Hale County, irrigation in 78
Halff Brothers, irrigation plant of 57
Hall, F. S., irrigation plant of 49
Halley, R. B., well plants of 102
Hambert Brothers, lands of, irrigation of 38
Hamshire, wells near, rice irrigation from 96-97
Harbart-Stafford Rice Company, pumping plant of 110, 111
Hargus & Poole, irrigation plant of 64
Harper Spring, irrigation from 77
Harris County, rice cultivation in 100-102
rice culture in, area devoted to 124
wells in, rice irrigation from 100
Harris County Rice Company, plant of 101
Harris Lake, irrigation from 63
Hartley County, irrigation in 79
Haskell County, irrigation in 78-79
Hatch John, irrigation of land owned by 18
Hawkins, Thomas, pumping plant of 37
Hays County, irrigation in 62
Hempstead, rice section extended to 82
Herbert, W. P., area irrigated by 78
Hermosura ditch, features of 19
map showing 18
Hidalgo, irrigation at 69
Hidalgo County, irrigation in 69
Higbee, R. E., rice irrigation by 117, 118
Highland Canal, map showing 24
Hill, T. A., area irrigated by 118
Hill-Brown Rice Land and Irrigation Company, plant of 100
Hillebrandt Bayou, rice cultivation on 92-93
Hodges, G. W., irrigation plant of 45-46
Holiday Creek, dam across, features of 79
Holliday, J. T., area irrigated by 60
Honey Creek, irrigation from 42
Hoopes, J. H., farm of, map showing location of 86
rice cultivation by 91
Hoover, A. J., irrigation plant of 76
Hosier Brothers, irrigation plant of 20-21
Houston, rice cultivation near 100-101
Hudgins Brothers, rice cultivation by 116
Hudson & Ayres, area irrigated by 116
rice irrigation plant of 82-83
well plant owned by 112

Page
Huffman, M., irrigation plant of 49
Hunger, T., irrigation plant of 48
Hutcheson, W. D., irrigation plant of 39
Hutson, W. F., reference to paper by 9, 13

I.

Idlewild, irrigation near 64
Illinois Irrigation Company, work proposed by 124
Indelkofer-Gilder ditch, features of 28
India, irrigation near 17
Indians, irrigation systems of, antiquity of 15
Irion County, irrigation in 71
Irrigation, antiquity of, in El Paso Valley 15
antiquity of, in Texas 11
laws pertaining to, statement of 125-127
methods of 11-12
necessity of, in middle Texas 13
pumping water for, diagram showing horsepower required for 84
systems of, promotion of 12
Irrigation systems, groups of, division of the State into 12
Irvin, J. E., area irrigated by 116
Ischy, John, irrigation plant of 77

J.

Jackets, Paul, area irrigated by 116
Jackson County, rice cultivation in 119
rice culture in, area devoted to 124
Jackson Lake, irrigation from 105
Jahn, G. A., irrigation plant of 104
Japonica, irrigation near 42
Jarvis, R. L., irrigation plant of 45-46
Jeff Davis County, ditches in 21
Jefferson County, rice cultivation in 86-97
rice culture in, area devoted to 124
rice irrigation in, map showing 86
table showing 88
soil in, character of 89
wells in, rice irrigation from 96-97
Jefferson County Rice Company, farm of, map showing 90
irrigation plant of 90-91
pumping station of, plate showing 90
Jenson, W. J., irrigation plant of 46
Joe Glenn ditch, irrigation by 71
Johnson, O. R., area irrigated by 118
Johnson & Jensen, area irrigated by 118
Johnson Fork of Guadalupe River, pumping plant on 42
Johnson Fork of Llano River, irrigation plants on 43, 45
Johnson grass, cultivation of 27, 30
Jones, E. M., irrigation plant of 41
Jones, F. E., well plant of 101
Jones, J. C., irrigation plant of 62
Jones, W. C., well plant of 111
Jones & Payne, irrigation plant of 72-73
Joy, John, dam built by 44
Junction City, irrigation near 44, 45, 46, 47, 48, 49-50
pumping plant near 44

K.

Page.
Kaiser, W. C., irrigation plant of 42
Kaley & Fuller, irrigation plant of 63
Kampman, Caroline, irrigation plant of 54
Katy, rice cultivation near 101 102
Kelley, E. F., irrigation plant of 45
Kelley, W. H., irrigation plant of 45
Kelley, W. S., irrigation plant of 74
Kellis irrigation system, features of 70
Kemper & Lasker, irrigation plant of 79
Kerr County, irrigation in 42
Kilgore, M. H., irrigation plant of 64
Killeen, irrigation near 76
Kimble County, irrigation in 42-48
irrigation systems in, map showing 43
King ranch, irrigation plant on 60
King Sisters, irrigation plant of 37
Kinney County, irrigation in 28-29
Kirby, J. W., area irrigated by 97
Kitchen ditch, features of 35
map showing 31
Kleberg, R. J., irrigation plant operated by 60
Knight spring, irrigation from 77
Koelblen, Jacob, irrigation plant of 55
Kyac Creek, irrigation from 46 47

L.

Labelle, rice cultivation near 91-92
Laguna, irrigation near 42
La Loma, irrigation near 17
Lampasas, irrigation plant near 75
Lampasas County, irrigation plant in 75
Landa, H., irrigation plants of 60
Landrum, William, irrigation plant of 42
Lands, cattle, extent of 11
Lasalle County, irrigation in 63
Las Moras Creek, flow of 28
irrigation from 28 30
map showing 29
Laws pertaining to irrigation, statement of 125 127
Layton irrigation plant, features of 57
L. C. pasture, irrigation of 50
Leakey, irrigation near 41-42
Lee, W. T., irrigation plant of 80
Leech, J. W., area irrigated by 118
Lenzen, G. P., irrigation plant of 61
Leon ditch, map showing 18
Leon spring, irrigation from 19
Leona River, character of 65
flow of 66
irrigation plants along 65-67
Leoncito Creek, ditches along 20
Lepan Creek, irrigation from 74
Levees, building of, for rice-farm canals, plate showing 120
Liberty County, rice cultivation in 99 100
rice culture in, area devoted to 124
rice irrigation in, map showing 87
wells in, rice irrigation from 99 100
Limbia Creek, irrigation from 21
Limestone County, irrigation in 79 80
Linderholm, John, rice irrigation by 114, 116
Lindsey, D. E., irrigation plant of 20
Lippard, J. K., irrigation plant of 4-41
Page.
Lissie, rice irrigation near 114 115
Lithgow, F. H., irrigation plant of 68 69
Little Paint Creek, irrigation from 47-48
Little River, irrigation from 77
Llano Estacado, features of, and irrigation plants on 78
Llano River, irrigation from 42 51
Locke, Otto, irrigation plant of 60-61
Long, A. B., irrigation plant of 44
Longworth & Caylor, area irrigated by 116
Louis, W. S., area irrigated by 118
Louise, rice cultivation near 118 119
well plants near 116
Lovell Brothers, farm of, map showing location of 86
rice cultivation by 92
Lowe, Q., irrigation plant constructed by 47
Lower ditch, irrigation by 66
Lowman, R. J., irrigation plant of 62

M.

Mabry, A. F., irrigation plant of 71 72
McBride & Lester, area irrigated by 116
McCan, James, area irrigated by 60
McClelland, C. E., statement by, relative to irrigation in Hale County 78
McDowell, W. G., irrigation plant of 59
McFadden & Wiess, farm of, map showing location of 86
rice cultivation by 96
McGee Irrigation Company, plant of 70
McGovern ditch, features of 28
McHenry, S. A., area irrigated by 60
McLain, George, rice irrigation by 115, 116
McLane, J. B., irrigation plant of 77
McLane & Crain, irrigation plant of 77
McLaughlin, S. W., irrigation plant of 40
McManus, G. J., rice irrigation by 96-97
McNeill, P. E., irrigation plant of 60
Madre ditch, dam supplying, plate showing 26
Madrigal, S. V., irrigation plant of 69
Magruder, ——, irrigation plant of 104
Malmquist, C. T., rice irrigation by 115, 116
Mamie ditch, features of 34-35
flexible pipe joint used on, figure showing 34
map showing 31
Marble Falls, irrigation at 76
Margueretta canal, features of 22-23
flume of, across Pecos River, plate showing 22
head gate of, plate showing 22
map showing 22
sluice gate used on, plate showing 24
West Valley ditch of, plate showing 22
Marshall, Frank, rice irrigation by 111, 112
Martinez Creek, irrigation plant in valley of 55
Masterson, B. T., irrigation plant of 64
Masterson, W. T., rice cultivation by 105
Matagorda Company, rice irrigation by 121-122
Matagorda County, areas irrigated in, summary of 122 123
levees for canals in, plate showing building of 120

Page.
Matagorda County, rice cultivation in. 121-123
rice culture in, area devoted to 124
rice planting in, plate showing engines breaking sod for 120
Mauritz, N. P., rice cultivation by 119
Maverick County, irrigation in 68
Maxwell, Z. T., irrigation plant of 38
Mayes, J. T., irrigation plant built by 50
Mayfield, D. B., rice cultivation by 119
Meadow Brook farm, irrigation on 100-101
Medina River, pumping plant on 64
Meerscheidt Brothers, irrigation plant of 58
Menard County, irrigation systems in 30-38
Menardville, dam near, features of 32
irrigation near 30-35
irrigation systems at and near, map showing 31
Menge, William, irrigation plant of 50
Messinger, W. D., area irrigated by 60
Metcalf & Sims, irrigation plant of 73
Mexia, irrigation at 79-80
Milam County, irrigation in 77
Mill Creek, irrigation from 103
Miller, W. W., area irrigated by 116
Mills County, pumping plants in, damage to 75
Milner, James, area irrigated by 118
Mission ditches, features of 51-54
Mission Farm Company, irrigation plant of 58
Mobeetie, irrigation at 79
Montell, irrigation at 42
Moore, Ed., farm of, map showing location of 86
rice cultivation by 91
Moore, W. S., area irrigated by 116
Moore-Cortez Canal Company, area irrigated by 123
plant of 121
Moos, W. G., irrigation plant of 43-44
Morales, M., irrigation plant of 50
Moritz, M. P., rice cultivation by 119
Morrison, T. W., irrigation plant of 78
Mott, Charles, irrigation plant of 73
Mountain Home, irrigation near 42
Mud Creek, irrigation from 27-28
irrigation from, map showing 28
Mulato canal, features of 20
Mulberry Spring, flow of 66
Munson, H. and G., irrigation plant of 106
Myers, Charles, irrigation plant of 81

N.

Neches River, rice cultivation on 95-96
Neizer, William, area irrigated by 118
Nelson, John, irrigation plant of 39
Nelson, Oscar, area irrigated by 118
Nelson, P. A. E., area irrigated by 118
Nelson, W. J., well plant of 101
Nelson Brothers, area irrigated by 118
Nesbett, H. H., irrigation plant of 79
New Braunfels, irrigation at and near 60-61
Newell, F. H., letter of transmittal by 9
Nile Valley Company, area irrigated by 123
irrigation plant of 122
pumping plant of, plate showing 122

Page.
Nordin, P. H., rice irrigation by 117, 118
Normanna, irrigation near 60
North Laredo, irrigation plants at 68-69
Noyes ditch, construction, cost, and features of 31-33
Nueces County, irrigation in 60
Nueces River, irrigation from upper 39-42
irrigation systems along lower 63-65
Nye, F. C., irrigation plant of 68

O.

O'Donnell, J. H., irrigation plant of 100
Old Mission ditch, construction of 31
Olesen, A. P., area irrigated by 118
Olesen, D., rice irrigatien by 117
Oliver, Rod., irrigation plant of 106
Orange, rice cultivation near 97-98
Orange County, rice cultivation in 97-98
rice culture in, area devoted to 124
rice irrigation in, map showing 86
soil in, character of 97
Orange County Rice Company, irrigation plant of 98
Owens, W. J., pumping plant operated by 44
Oyster Creek, irrigation from 105

P.

Palvo Irrigation Company ditch, features of 26
Parsons, W. H., irrigation plant of 79
Paterson artesian well, depth and flow of 65
Patterson, W. B., irrigation plant of 41-42
Peach trees, killing of, by flood 15
Pecos County, irrigation in 17-19, 20, 24
Pecos River, course and character of 21
Margueretta canal flume across, plate showing 22
irrigation systems west of 13-21
Pecos River Irrigation Company, features of ditch of 23-24
Pecos River Company, irrigation controlled by 19
Pecos Valley, fertility of 21
irrigation systems in 21-24
Perry, W. J., irrigation plant of 39
Peterson, Otto, rice cultivation by 119
Phantom Lake, location and features of 15
Pickett, A. G., irrigation plant of 58
Piedras Creek, aqueduct carrying Espada ditch across, plate showing 52
Pierce, well plants near 116
Pietsch, L., area irrigated by 116
Piloncillo, manufacture of 70
Pine Island Bayou, rice cultivation on 94-95
Pioneer Canal Company, measuring weir adopted by, plate showing 24
Place, C. A., farm of, map showing location of 86
rice cultivation by 92-93
Planters' Canal Company, area irrigated by 122, 123
Pool, J. R., irrigation plant of 20
Pordo, E., irrigation plant of 80

Page.

Port Arthur Irrigation Company, map showing location of .. 86
plant of 95
rice thrasher on plantation of, plate showing 90
Praeger, Otto, irrigation plant of 57
Prairie Bluff Rice Company, area irrigated by 123
location of canal of 122
Presidio, irrigation near 20
Presidio County, irrigation in 19-20
Pridhams Lake, rice irrigation from 123
Prospect Hill, irrigation near 58
Pruett ditch, map showing 16
Pulliam prong of Nueces River, irrigation from 39, 41
Pumping, horsepower required for, for various lifts and acreages, diagram showing 84

R.

Radford & Co., rice cultivation by 101
Rankin, Carl, area irrigated by 60
Rathbone, Harry, irrigation plant of 123
Rathbone & Wofford, rice farm of 123
Rathjen, F. H., area irrigated by 79
Ray, T. L., irrigation plant of 19
Raywood Rice Canal and Milling Company, plant of 99
Red, M., irrigation plant of 40
Red Bluff Rice Company, plant of 111-112
Reeves County, irrigation in 16-17
Reid, J. H., irrigation plant of 49-50
Rembold, P. J., irrigation plant of 44
Reynolds, Charles, installation of irrigation plant by 60
Reynolds, George, installation of irrigation plant by 60
Reynolds Land and Cattle Company, irrigation plant of 79
Rice, area devoted to culture of, by counties 124
cultivation of, amount of water required for 83-84
conditions requisite for 82, 83
plate showing preparations for 120
irrigation of 82-124
general features of 82-86
proposed plants for cultivation of 124
Rice belt, irrigation in 82-124
map showing 83
Rice straw, baling of, plate showing 122
Rice thrasher, plate showing 90
Richards, John, irrigation plant of 62
Richland Spring, irrigation from 38
Richmond, rice cultivation near 105
Ring, H. F., well plant of 101
Rio Frio, irrigation from 41-42
Riofrio, irrigation near 41-42
Rio Grande, features of valley of 68
flow of, unreliability of 15
irrigation from 13-15
irrigation plants along lower 68-70
rice cultivation along 82
Rio Rosa ditch, features of 19-20
Roberts, T. G., well plant of 101

Page.

Robertson, J. K., area irrigated by 60
Rock Island, rice irrigation near 110, 111, 112
Rolf, T., area irrigated by 118
Rooney ditches, features of 18-19
Roswell, N. Mex., irrigation works at and near 21
Rough Creek, irrigation near 38
Royall, Mrs., irrigation plant of 19
Rusk, J. T., rice farm of 123

S.

Saddler & Rome, rice cultivation by 119
Saddler & Thomas, rice cultivation by 119
Saddler & Thomason, rice cultivation by 119
St. Isabella Canal, map showing 16
St. Marys ditch, map showing 26
San Angelo, irrigation plants south of, map showing 72
San Antonio, artesian wells in and near, irrigation from 54-56
geographic center of 52
irrigation ditches at, antiquity of 51
irrigation systems at and near 51-62
sewage from, use of, for irrigation 56-57
sewer-farm ditch at, cross section of 56
San Bernard Creek, rice cultivation on 103-104
Sand screen for water wells, figure showing 113
Sandy Point, rice cultivation near 105
San Elizario, irrigation ditch near, features of 14-15
San Felipe Agricultural, Mechanical, and Irrigation Company, ditches owned by 25-26
San Felipe Creek, irrigation from 25
San Felipe ditch, dam supplying, plate showing 26
map showing 26
San Gabriel River, irrigation plants along 75-77
San Jacinto Rice and Irrigation Company, work proposed by 124
San Jose ditch, history of 53
San Jose Irrigation Company, plant of 74
San Juan ditch, irrigation by 53
San Marcos, irrigation near 62
San Marcos River, irrigation plants on 61-62
San Marcos Water Works Company, irrigation plant of 61
San Pedro ditch, irrigation by 52
San Pedro Spring, irrigation from 19
San Saba, irrigation systems near 36, 37, 38
San Saba County, irrigation in 35-38
soil in, character of 35, 38
San Saba mission, establishment of 31
San Saba River, dam across, features of 32
San Saba Valley, irrigation in 30-38
proposed irrigation system in 37-38
Santa Lucia, irrigation near 19
irrigation near, map showing 24
Santa Rosa Spring, irrigation from 19
Sapp, N. B., rice cultivation by 99-100
Saragossa, irrigation near 17
Schult, Oscar, rice irrigation by 118
Schumacher & Fox, farm of, map showing location of 86

Page.
Scott, L. A., irrigation plant of 19
Scroggins, O. B., area irrigated by 118
Seafeldt, H. G., irrigation plant of 64
Sealy, rice cultivation near 104
Seminole Negro Indians, ditch used by 28
Sewage, use of, for irrigation 56-57
Sexton Canal Company, area irrigated by 123
Shackelford County, irrigation in 78-79
Shafter, irrigation at and near 19, 20
Shappard, N. H., irrigation plant of 76
Shealy, Will, installation of irrigation plant by 60
Sheldon, rice cultivation near 100
Sheldon Canal Company, plant of 100
Sherwood, irrigation near 71
Shockley, W. A., irrigation plant of 40
Sieker, L. P., dam of, cross section of 34
dam of, features of 33-34
Sigler, H. C., area irrigated by 111
pumping plant of 110
Sleicher & Crouch, rice farm of 123
Sloan, irrigation at 35-36
Sloan, J. A., & Sons, ditch owned by, features of 35-36
Sloan irrigation system, map showing 36
Small, A. W., irrigation plant of 112
Smith, F. B., irrigation plant of 100-101
Smith, H. F., rice farm of 105
Smith, J. F., & Bro., irrigation plant of 75
Smith, J. G., & Bro., irrigation plant of 106
Smith, T. L., acknowledgements to 13
Smith ditch, features of 29
Smithers Lake, irrigation from 104
Socorro, irrigation ditch near, features of 14-15
Soil, character of 35, 38, 39, 42
South Concho Irrigation Company, plant of 73-74
South Llano River, flow of 51
irrigation from 48-49
Southern Rice Company, farm of, map showing location of 86
irrigation plant of 92
Southwestern Company, area irrigated by 97
Southwestern Irrigation Company, ditches owned by, features of 18
Sparks, J. W., irrigation plant of 40
Spitgarber ranch, irrigation at 30
Spivy, —, area irrigated by 97
Spring Creek, irrigation from 73
Springs, occurrence and use of 11
occurrence and volume of, Edwards Plateau 25
Staked Plains, features of, and irrigation plants on 78
Stalte, Fred, irrigation plant of 81
Staples, irrigation near 62
Starty, A. G., irrigation plant of 61
State Agricultural and Mechanical College, irrigation plant of 58-59
Stephenson, W. M., irrigation plant of 48-49
Sterling, irrigation near 70
Sterling County, irrigation in 70
Sterner, E. G., area irrigated by 118
Sterns, H. T., irrigation plant of 76
Stewart, Alec., irrigation plant of 50
Stewart, D. L., irrigation plant of 50
Stewart canal, irrigation by 122
Stewart Canal Company, area irrigated by 123
Stilson, rice irrigation near 99
Stockdick, A., well plant of 101
Stone, Heber, irrigation plant of 103
Stone, James and Stephen, irrigation plant of 103-104
Stoval, A. M., area irrigated by 60
Stratton, Judge, pumping plant installed by, features of 29
Stratton ditch, features of 29
Strickland, W. S., area irrigated by 116
Striegler, O., irrigation plant of 31
Stubenrauch, J., irrigation plant of 79-80
statement of, as to value of irrigation 80
Sunwall, N. J., area irrigated by 118
Swag ditch, map showing 26
Swinden Pecan Orchard Company, irrigation plant of 74-75

T.

Tarlton, G. D., irrigation plant of 50
Taylor, irrigation near 76
Taylor, J. H., irrigation plant of 25
Taylor, J. S., irrigation plant of 64
Taylor, M. A., irrigation plant of 64-65
Taylor, M. M., irrigation plant of 41
Taylor, T. C., irrigation plant of 48
Taylor, W. W., irrigation plant of 46
Taylors Bayou, dam across, necessity of 88
rice cultivation on 88-92
Tedford, Robert, irrigation plant of 42
Templeton ranch, irrigation on 21
Terry, rice cultivation near 97-98
Texas Land and Irrigation Company, plant being installed by 124
Texas Pacific Railroad, irrigation systems north of 78-79
Thompson, A. S., area irrigated by 118
Thompson, N., area irrigated by 118
Thrailkill, W. F., irrigation plant of 42
Tijerina, Thomas, irrigation plant of 70
Tom Green County, irrigation in 71-74
irrigation in, map showing 72
Tornillo Creek, irrigation from 20
Torres, Cæsario, irrigation of land by 18
Townes, H. E., irrigation plant of 77
Townes, J. C., statement by, of laws pertaining to irrigation 125-127
Townley, J. C., rice irrigation by 115, 116
Toyah Creek, course and character of 15, 16
irrigation from 16-17
map showing 16
Toyah Creek Irrigation Company, water from Toyah Springs deflected to ditch of 16
Toyah Lake, location and character of 17
Toyah Springs, irrigation from 16, 17
location and features of 15-16
Toyahvale, irrigation near 17

Page.
Trans-Pecos Texas, irrigation systems in. 13-21
reservoir sites in. 13
soil of, character of 13
Travis County, irrigation plants in 75-76
Treadway Canal Company, work contemplated by 124
Trinity River, rice cultivation on 98-99
Trinity River Rice and Irrigation Company, plant of 98-99
Truehart ditch, location of 54
Turtle Bayou, rice cultivation on 98-99
Twin Mountain ditch, irrigation by 73

U.

Uhl, Alexander, irrigation plant of 63
Undershot water wheels, use of, for irrigation 62
United States, irrigation of land by 18
Upper ditch, irrigation by 66
Upper Labor ditch, history of 52
Uvalde, irrigation near 64
Uvalde County, irrigation in. 42, 64, 65-66
soil in, character of 42

V.

Valverde County, irrigation in 25-27
Vandalle, Herman, irrigation plant of 55
Vanderstücken, Emile, pumping plant of, features of 35
Vaughan Agricultural and Improvement Company, construction of ditch by 31-32
Vaughan ditch, map showing 31
Vick, George, irrigation plant of 112
rice irrigation by 82-83
Victoria, irrigation near 60
rice cultivation near 123
Victoria County, rice cultivation in 123
rice culture in, area devoted to 124
Victoria Rice and Irrigation Company, plant of 123
Viterbo Brothers, farm of, map showing location of 86
rice cultivation by 93

W.

Waco, irrigation at and near 80-82
Wades, irrigation at 60
Walker & Cain, pumping plants of 106
Wallace-Radford Company, canal system proposed by 124
Waller County, rice cultivation in 103
rice culture in, area devoted to 124
Walnut Creek, irrigation from 50
Walters, Albert, irrigation plant of 55
Walton, A. Y., jr., organization of Espada Ditch Company by 53
Ward, J. C., farm of, map showing location of 86
rice cultivation by 89-90
Ward, L., rice cultivation by 119
Ward County, irrigation in 22-23
Washington County, rice cultivation in 103
rice culture in, area devoted to 124
Water, method of obtaining supply of 11
Water course, definition of, by Cooley 125
Waugh, W. H., area irrigated by 118
Wayland, J. H., irrigation plant of 78
Webb County, irrigation in 68-69
Weir, measuring, plate showing 24
Welch, Silas, irrigation plant of 42
Wells, sand screen for, figure showing 113
Wells, artesian, irrigation from, in and near San Antonio 54-56
West & Burnet, irrigation plant of 37
West Bear Creek, irrigation from 49-50
Westmoreland, J. W., rice irrigation by 110, 111
Wetzel, John, area irrigated by 118
Wharton, rice cultivation near 116, 119-120
Wharton County, rice cultivation in 116-119
rice culture in, area devoted to 124
Wheeler, H. C., rice irrigation by 97
Wheeler County, irrigation in 79
Wilkerson, A. W., irrigation plant of 102
Wilkinson, W. J., irrigation plant of 31
Williams, O. W., acknowledgments to 13
Williams, W. D., irrigation plant of 71
Williams, Z. I., J. B., and J. A., irrigation plant constructed by 16
Williamson County, irrigation in 76-77
Windmills, insufficiency of, for rice irrigation 112-113
use of 11
Wood, G. F., irrigation plant of 47-48
Wood, W. S., & Co., area irrigated by 118
Woods, J. H., irrigation plant of 41
Woods, Tom, irrigation plant of 39
Woodward, W. F., irrigation plant of 40
Woolsey, area irrigated by 118
Worthington, Thomas, canal purchased by 13

Y.

Young County, irrigation in 78-79
Ysleta, irrigation ditch near, features of 14-15

Z.

Zavalla County, irrigation in 67

LIBRARY CATALOGUE SLIPS.

[Take this leaf out and paste the separated titles upon three of your catalogue cards. The first and second titles need no addition; over the third write that subject under which you would place the book in your library.]

Series.

United States. *Department of the interior.* (*U. S. geological survey.*)

Water-Supply and Irrigation Paper No. 71 Series I. Irrigation, 13 | Department of the interior | United States geological survey | Charles D. Walcott, director | — | Irrigation systems of Texas | by | Thomas U. Taylor | [Vignette] |

Washington | government printing office | 1902

8°. 137 pp., 9 pls.

Author.

Taylor (Thomas U.).

Water-Supply and Irrigation Paper No. 71 Series I, Irrigation, 13 | Department of the interior | United States geological survey | Charles D. Walcott, director | — | Irrigation systems of Texas | by | Thomas U. Taylor | [Vignette] |

Washington | government printing office | 1902

8°. 137 pp., 9 pls.

Subject.

Water-Supply and Irrigation Paper No. 71 Series I. Irrigation, 13 | Department of the interior | United States geological survey | Charles D. Walcott, director | — | Irrigation systems of Texas | by | Thomas U. Taylor | [Vignette] |

Washington | government printing office | 1902

8°. 137 pp., 9 pls.

Series O—Underground Waters.

WS 4. A reconnaissance in southeastern Washington, by I. C. Russell. 1897. 96 pp., 7 pls.
WS 6. Underground waters of southwestern Kansas, by Erasmus Haworth. 1897. 65 pp., 12 pls.
WS 7. Seepage waters of northern Utah, by Samuel Fortier. 1897. 50 pp., 3 pls.
WS 12. Underground waters of southeastern Nebraska, by N. H. Darton. 1898. 56 pp., 21 pls.
WS 21. Wells of northern Indiana, by Frank Leverett. 1899. 82 pp., 2 pls.
WS 26. Wells of southern Indiana (continuation of No. 21), by Frank Leverett. 1899. 64 pp.
WS 30. Water resources of the lower peninsula of Michigan, by A. C. Lane. 1899. 97 pp., 7 pls.
WS 31. Lower Michigan mineral waters, by A. C. Lane. 1899. 97 pp., 4 pls.
WS 34. Geology and water resources of a portion of southeastern South Dakota, by J. E. Todd. 1900. 34 pp., 19 pls.
WS 53. Geology and water resources of Nez Perces County, Idaho, Part I, by I. C. Russell. 1901. 86 pp., 10 pls.
WS 54. Geology and water resources of Nez Perces County, Idaho, Part II, by I. C. Russell. 1901. 87–141 pp.
WS 55. Geology and water resources of a portion of Yakima County, Wash., by G. O. Smith. 1901. 68 pp., 7 pls.
WS 57. Preliminary list of deep borings in the United States, Part I, by N. H. Darton. 1902. 60 pp.
WS 59. Development and application of water in southern California, Part I, by J. B. Lippincott. 1902. 95 pp., 11 pls.
WS 60. Development and application of water in southern California, Part II, by J. B. Lippincott. 96–140 pp.
WS 61. Preliminary list of deep borings in the United States, Part II, by N. H. Darton. 1902. 67 pp.
WS 67. The motions of underground waters, by C. S. Slichter. 1902. 106 pp., 8 pls.
B 199. Geology and water resources of the Snake River Plains of Idaho, by I. C. Russell. 1902. 192 pp., 25 pls.

The following papers also relate to this subject: Underground waters of Arkansas Valley in eastern Colorado, by G. K. Gilbert, in Seventeenth Annual, Part II; Preliminary report on artesian waters of a portion of the Dakotas, by N. H. Darton, in Seventeenth Annual, Part II; Water resources of Illinois, by Frank Leverett, in Seventeenth Annual, Part II; Water resources of Indiana and Ohio, by Frank Leverett, in Eighteenth Annual, Part IV; New developments in well boring and irrigation in eastern South Dakota, by N. H. Darton, in Eighteenth Annual Part IV; Rock waters of Ohio, by Edward Orton, in Nineteenth Annual, Part IV; Artesian well prospects in the Atlantic Coastal Plain region, by N. H. Darton, Bulletin No. 138.

Series P—Hydrographic Progress Reports.

WS 11. River heights for 1896, by A. P. Davis. 1897. 100 pp.
WS 15. Operations at river stations, 1897, Part I. 1898. 100 pp.
WS 16. Operations at river stations, 1897, Part II. 1898. 101–200 pp.
WS 27. Operations at river stations, 1898, Part I. 1899. 100 pp.
WS 28. Operations at river stations, 1898, Part II. 1899. 101–200 pp.
WS 35. Operations at river stations, 1899, Part I. 1900. 100 pp.
WS 36. Operations at river stations, 1899, Part II. 1900. 101–198 pp.
WS 37. Operations at river stations, 1899, Part III, 1900. 199–298 pp.
WS 38. Operations at river stations, 1899, Part IV. 1900. 299–396 pp.
WS 39. Operations at river stations, 1899, Part V. 1900. 397–471 pp.
WS 47. Operations at river stations, 1900, Part I. 1901. 100 pp.
WS 48. Operations at river stations, 1900, Part II. 1901. 101–196 pp.
WS 49. Operations at river stations, 1900, Part III. 1901. 197–292 pp.
WS 50. Operations at river stations, 1900, Part IV. 1901. 293–388 pp.
WS 51. Operations at river stations, 1900, Part V. 1901. 389–488 pp.
WS 52. Operations at river stations, 1900, Part VI. 1901. 489–575 pp.
WS 65. Operations at river stations, 1901, Part I. 1902. 334 pp.
WS 66. Operations at river stations, 1901, Part II. 1902. 188 pp.

Progress reports may also be found in the following publications: Tenth Annual, Part II; Eleventh Annual, Part II; Twelfth Annual, Part II; Thirteenth Annual, Part III; Eighteenth Annual, Part IV; Nineteenth Annual, Part IV; Twentieth Annual, Part IV; Twenty-first Annual, Part IV; Twenty-second Annual, Part IV; Bulletin No. 131; Bulletin No. 140.

PAPERS RELATING ESPECIALLY TO IRRIGATION.

SERIES I—IRRIGATION.

WS 2. Irrigation near Phoenix, Ariz., by A. P. Davis. 1897. 98 pp., 31 pls. and maps.
WS 5. Irrigation practice on the Great Plains, by E. B. Cowgill. 1897. 39 pp., 11 pls.
WS 9. Irrigation near Greeley, Colo., by David Boyd. 1897. 90 pp., 21 pls.
WS 10. Irrigation in Mesilla Valley, New Mexico, by F. C. Barker. 1898. 51 pp., 11 pls.
WS 13. Irrigation systems in Texas, by W. F. Hutson. 1898. 68 pp., 10 pls.
WS 17. Irrigation near Bakersfield, Cal., by C. E. Grunsky. 1898. 96 pp., 16 pls.
WS 18. Irrigation near Fresno, Cal., by C. E. Grunsky. 1898. 94 pp., 14 pls.
WS 19. Irrigation near Merced, Cal., by C. E. Grunsky. 1899. 59 pp., 11 pls.
WS 23. Water-right problems of Bighorn Mountains, by Elwood Mead. 1899. 62 pp., 7 pls.
WS 32. Water resources of Porto Rico, by H. M. Wilson. 1899. 48 pp., 17 pls. and maps.
WS 43. Conveyance of water in irrigation canals, flumes, and pipes, by Samuel Fortier. 1901. 86 pp., 15 pls.
WS 70. Geology and water resources of the Patrick and Goshen Hole quadrangles, Wyoming, by G. I. Adams. 1902. 50 pp., 11 pls.
WS 71. Irrigation systems of Texas, by T. U. Taylor. 1902. — pp., 9 pls.

The following papers also relate especially to irrigation: Irrigation in India, by H. M. Wilson, in Twelfth Annual, Part II; two papers on irrigation engineering, by H. M. Wilson, in Thirteenth Annual, Part III.

Correspondence should be addressed to

The DIRECTOR,
UNITED STATES GEOLOGICAL SURVEY,
WASHINGTON, D. C.